ANALYSIS OF INFILLING PROJECTS AFFECTING FISH HABITAT IN THE GREAT LAKES (1997 – 2001)

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ABSTRACT

This report provides habitat biologists with examples of how the Habitat Alteration Assessment Tool (HAAT) can be applied as an assessment tool in the review of development proposals. Development proposals received between 1997 and 2001 were reviewed for trends in project design, size, and location. Twenty-six infilling projects were selected for a detailed paper review to determine if projects would have resulted in no net loss of fish habitat based on the results of HAAT. A subset of these were compared for analysis, using actual site conditions documented in the field, to determine project compliance and effectiveness of compensation efforts required by DFO approvals.

The case study analysis demonstrated that most infills are small (< 50 m^2); however, cumulatively they represent a significant loss in the productive capacity of fish habitat. Field assessments determined that project compliance is often an issue, reinforcing the need for project audits to ensure compliance. The findings of this report demonstrate the benefits of using a quantitative, scientifically defensible tool, such as HAAT, in achieving project success.

RÉSUMÉ

Le présent rapport fournit aux biologistes de l'habitat des exemples sur la façon dont l'Outil d'évaluation de l'altération de l'habitat (OEAH) peut être appliqué comme outil d'évaluation dans l'examen des propositions de développement. Les propositions de développement reçues de 1997 à 2001 ont été évaluées en fonction des tendances dans la conception, la grandeur et l'emplacement des projets. Vingt-six projets de remplissage ont été sélectionnés pour une étude détaillée des dossiers afin de déterminer si les projets n'auraient entraîné aucune perte nette de l'habitat du poisson basé sur les résultats de l'OEAH. Un sous-ensemble de ces résultats a été comparé aux fins d'analyse, en utilisant les conditions du site actuelles documentées sur le terrain pour déterminer la conformité du projet et l'efficacité des efforts de compensation requis par les approbations du MPO.

L'analyse de l'étude de cas a démontré que la plupart des remplissages sont petits (< 50 m^2); cependant, ils représentent cumulativement une perte importante de la capacité de production de l'habitat du poisson. Les évaluations sur le terrain ont déterminé que la conformité du projet pose souvent problème, ce qui accentue la nécessité de la vérification de projet pour atteindre la conformité. Les résultats de ce rapport démontrent les avantages de l'utilisation d'un outil quantitatif et scientifiquement justifiable, tel que l'OEAH, afin d'assurer la réussite du projet.

1.0 INTRODUCTION

The Canadian federal *Fisheries Act* contains provisions for the conservation and protection of fish habitat. It recognizes the importance of healthy productive habitats to overall fish production and to fisheries. Specifically, the harmful alteration, disruption, or destruction (HADD) of fish habitat is prohibited unless the federal minister issues an Authorization under Section 35 of the *Fisheries Act*. Proponents of development potentially affecting fish habitat are not required automatically to apply for approval but rather are subject to prosecution if they proceed and cause a HADD without an Authorization. In 1986, Fisheries and Oceans Canada (DFO) issued the Policy for the Management of Fish Habitat (DFO 1986) which clarified federal goals and objectives in relation to the *Fisheries Act*. Central to the Policy is the guiding principle of 'no net loss of the productive capacity of habitats' (NNL). As a result, if a proposed HADD is judged unacceptable then the project will be denied. If the proposed HADD is judged acceptable, all available mitigation techniques should be used to minimize the size of the HADD. If there is still a HADD after mitigation, compensation must be applied so that NNL is achieved.

The Ontario-Great Lakes Area (OGLA) Fish Habitat Management Program is responsible for the delivery of services associated with Section 35 of the *Fisheries Act*. The OGLA Fish Habitat Management Program uses a habitat referral process to review, under the federal *Fisheries Act*, projects that are in and around water. Referrals are requests for review of proposed development activities that may harmfully impact fish habitat (Figure 1). These include activities such as dredging, infilling, stream crossings (e.g., culverts, bridges), stream realignment, and shoreline hardening. When a proponent submits a proposal, it is evaluated by a biologist to determine whether mitigation and/or compensation is required to avoid, reduce, or offset losses or changes in the productive capacity of fish habitat.

A number of projects reviewed by OGLA involve the infilling of fish habitat due to various types of development activities (e.g., marina developments, breakwaters, and shoreline stabilization projects). Upon review, projects such as these are typically found to result in a HADD and therefore require an Authorization under Section 35 of the *Fisheries Act*. Authorizations will be denied for these projects if:

1) the negative impact(s) of the proposed work cannot be suitably compensated for by the proponent of the HADD; or,

2) the work will result in significant environmental effects, as determined from the result of the *Canadian Environmental Assessment Act* (conducted as a requirement for most HADD Authorizations).

For projects where an Authorization will be issued, the OGLA biologist determines whether the proposed compensation is sufficient to achieve DFO's policy of NNL. Among the compensation options which are most frequently contemplated for achieving NNL for infilling projects, the following options, presented in the order of preference from an ecological perspective, are commonly used (DFO 1986):

- create similar habitat at or near the development site within the same ecological unit
- create similar habitat in a different ecological unit that supports the same stock or species
- increase the productive capacity of a different ecological unit that supports the same stock or species
- increase the productive capacity of existing habitat for a different stock or a different species of fish either on or off site.

Once it is agreed that the compensation and mitigation measures proposed are acceptable, the OGLA biologist will issue the Authorization and the proponent may then proceed with the project (Figure 1).

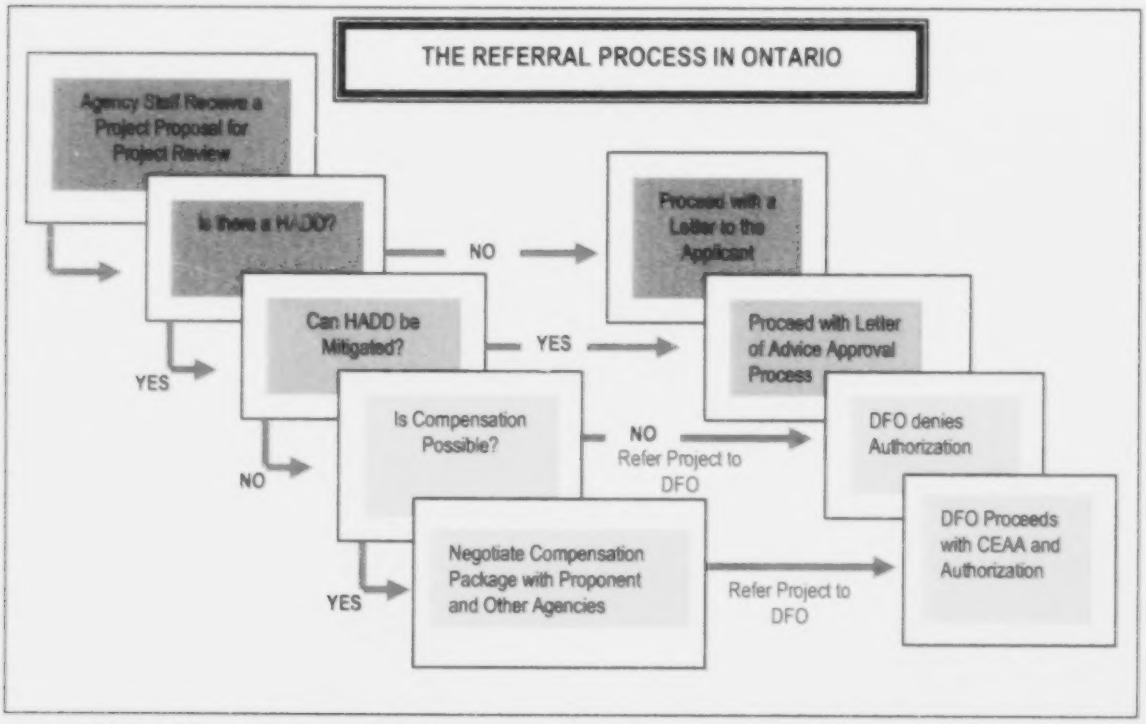

Figure 1. Steps followed by Ontario DFO Habitat Biologists upon Receiving a Project Proposal.

Decisions regarding the size of loss of fish habitat and the attainment of NNL are expected to be scientifically defensible. It is not always possible to undertake the scientifically appropriate experimentation to assess how human development activities impact fish habitat (Minns et al. 1996). Hence, it is necessary to devise ways to assess the impacts of actual developments and to use the accumulation of insights and understanding to foster adaptive management. Minns (1997) developed a numerical framework for applying the NNL principle to measure the net change of productive capacity of fish habitats. This framework was subsequently applied operationally to lake habitats, first in the Great Lakes region, and later in other regions of Canada, in a web-

based software application using the generic name, Defensible Methods (Minns and Nairn 1999; Minns et al. 2001). The specific application used to assess net change in Great Lakes lacustrine habitats was, until recently, known as the Habitat Suitability Matrix (HSM) method, however it is now known operationally as the Habitat Alteration Assessment Tool (HAAT).

During the course of its development, HAAT has been applied to several proposed activities on the Great Lakes as a collaboration between the Environmental Science group in the Central and Arctic Region of DFO and the Ontario-based arm of Fish Habitat Management (FHM), OGLA. From those applications, it became clear that infilling of fish habitat, as part of many development activities, was often an obstacle to the attainment of NNL despite efforts to enhance and create associated habitats. As a result, a joint project was undertaken between DFO Environmental Science (C.K. Minns and J.E. MacNeil), FHM-OGLA (D. Ming), and Azimuth Environmental Consulting Inc. (AEC; S. Murphy) to complete a retrospective review of lake projects involving infilling in the Great Lakes between 1997 and 2001. AEC was funded by the Canadian Environmental Assessment Agency (CEAA) to undertake an audit analysis of selected authorized projects, involving field assessment, in Nottawasaga Bay, Georgian Bay. Meanwhile, DFO undertook a paper review of all authorized Great Lakes activities, applying HAAT to a representative sample. The main objectives of this project were to a) assess the scope of infilling activities on the Great Lakes in general and, b) apply HAAT to a subset of case studies to provide an independent standardized assessment of whether NNL was achieved.

This report presents collaborative results from DFO and AEC using a combination of case study data and field verification studies to assess infilling projects. A statistical analysis of the number and type of projects reviewed by OGLA between 1997 and 2001 was completed to quantify areas of infilling within the Great Lakes. From this exhaustive list, a more detailed case study analysis of selected project sites was completed, using HAAT to assess the adequacy of proposed compensation efforts and their effectiveness for achieving NNL.

The field study component of the project involved the verification of actual site conditions for projects that involved infilling. These projects were located primarily in Nottawasaga Bay. The intent of the field study was to assess project compliance and effectiveness in terms of the adequacy of implemented compensation efforts in relation to those required by the proponent in accordance with Federal *Fisheries Act* approvals. For each project visited in the field, a detailed analysis of actual and proposed habitat conditions was completed using HAAT.

The intent of the HAAT application was twofold. Firstly, to illustrate, using a paper review of selected case files, whether projects affecting fish habitat are anticipated to result in NNL of fish habitat. Secondly, to complete the HAAT analysis on a subset of projects using actual site conditions documented in the field, and compare results with the expected case. This approach was taken in order to:

1) identify whether compensation efforts, which aim to achieve a NNL of fish habitat, would have changed had the project been assessed using HAAT;

2) determine if NNL was achieved, according to HAAT, by the actual site conditions following project completion; and,

3) determine if the project was in compliance with DFO requirements.

2.0 OVERVIEW OF HAAT APPLICATION

HAAT provides a means of quantifying a net gain or loss of the natural productivity of fish habitats, or a net change in habitat conditions, resulting from development projects in lacustrine environments. This tool is a comprehensive way of determining the suitability of a proposed project by comparing the physical conditions of a site in the proposal stage (i.e., in the pre-development context) to the expected condition of the site once construction is complete (i.e., post-development scenario). The goal of HAAT is to provide DFO fish habitat biologists and project proponents with a supplementary tool for evaluating the impacts of proposals affecting aquatic shorelines, and guide the determination of adequate compensation ratios for attaining NNL.

The primary method used for site-specific applications in HAAT is the comparison of the pre- and post-development scenarios that are used to compute net gain or loss of suitable habitat (Minns et al. 2001). To complete the analysis, it is necessary to delineate areas of habitat to be affected by the proposed development (refer to Appendix A for application templates and Appendix B for examples of individual case study analysis). The change in the project area as a result of development is categorized five ways: area lost (LOSS), for example infilling; areas modified directly or indirectly by development (MODD and MODI, respectively); or areas created or modified as a result of compensation efforts (COMC and COMM, respectively). These areas are used in both the pre- and post-development scenarios. Once areas are recognized by these designations, they are further broken down into units (patches) that share a unique set of habitat conditions. Habitat conditions are based upon three habitat features with predetermined interval boundaries. Features include depth (0 - 1 m, 1 - 2 m, 2 - 5 m, 5 - 10 m, 10+ m), substrate (bedrock, boulder, cobble, rubble, gravel, sand, silt, clay, hardpan) and vegetative cover (submergent, emergent, no cover). A particular area is partitioned, by percentage, into each habitat feature's intervals so that the percentages within each feature total 100%.

An example of an area classified by the described set of conditions could be as follows: an area of infilling occupies 200 m^2 and is located entirely within the 0 - 1 m depth zone of a lake environment. As a result of infilling, this area can no longer be used by fish and therefore represents a loss of fish habitat equaling 200 m^2. Prior to development, the substrate within this 200 m^2 area within the 0 - 1 m depth zone was primarily cobble with boulders and gravel, with some areas of submergent vegetative cover. Using HAAT, the pre-development scenario would indicate it is entirely, or 100% within the 0 - 1 m depth zone, with a substrate composition of 60% cobble, 10% boulders, and 30%

gravel, with 20% vegetative cover and 80% no cover, all within the 200 m^2 infilled area. Using these data, HAAT computes habitat suitabilities for a complete list of fish species already incorporated into the HAAT application and organized by waterbody. The effect of the development is represented by changes to the suitable habitat supply for fish species categorized by adult thermal preference (i.e., warmwater, coolwater, and coldwater species), feeding group (i.e., piscivores or non-piscivores), as well as by life stage habitat (i.e., adult, spawning, and young of the year (YOY) stages).

The HAAT program assigns the habitat patches and their characteristics (input by the user) a suitability matrix for each species group and life stage combination (Minns et al. 2001). The program then calculates weighted suitable areas (WSAs) by multiplying the habitat area of each patch by a predetermined suitability value in the matrix. This allows for a comparison of the WSAs in the pre- versus the post-development scenario. For example, if the final HAAT results indicate that in the pre-development case the WSAs for adult coldwater piscivores is less than that in the post-development case, it can be inferred that the project resulted in some net gain of habitat for fish species within that thermal/feeding group and age class.

Typically, HAAT is utilized to assess proposed development activities in order to assist DFO in the consideration of approval. In these cases, the analysis is most effectively applied when quantitative estimates of site parameters (i.e., depth, cover, and substrate) are known in the pre-construction phase. An outcome is derived based upon predictions of physical changes in the aquatic environment resulting from the proposed activities. In the study presented here, the opposite scenario was also tested, with HAAT being applied to cases where the post-development site conditions were known from the field verification exercise. In these cases, pre-development site conditions were inferred, based upon a combination of documentation and best estimation when available information was lacking. HAAT was run twice for the field verified projects: once for the expected (predicted) scenario, and then again using actual site conditions. Results from the analyses of both the expected and actual cases were then compared.

3.0 METHODS

3.1 REFERRAL SUMMARY 1997 – 2001

Data were initially collected by searching DFO's Habitat Referral Tracking System (HRTS)[1]. HRTS is the database used by DFO habitat biologists to search and record project details for all proposals referred to DFO. HRTS was queried for all projects receiving a *Fisheries Act* Section 35 Authorization or Letter Of Advice (LOA) between January 1st, 1997 and December 31st, 2001. Using the number of projects received by DFO in this time period, a percentage of projects that were either authorized, given a LOA, or not completed were calculated. It should be noted that these values were derived from information retrieved from HRTS and are considered estimated values.

[1] Note that in May 2005, the Program Activity Tracking for Habitat (PATH) system was implemented, replacing the Habitat Referral Tracking System (HRTS) as DFO's national referral database system.

Projects authorized in this time period were grouped by project type (e.g., shoreline works, roads and bridges, instream works, etc.). Individual shoreline stabilization and instream filling projects receiving Section 35 Authorizations were reviewed in HRTS for information on the proposed type of construction (e.g., armourstone retaining wall, rock groyne, rock revetment, etc.), area of infilling, and project location. Where information was not available, appropriate hard copy files from OGLA district offices were sought and reviewed to extract the required information.

In addition to HRTS, AEC consulted with the Nottawasaga Valley Conservation Authority (NVCA) to identify potential project sites within the Nottawasaga Bay basin that had been reviewed by the NVCA as part of a partnership agreement with DFO. Information generated by NVCA was cross-referenced with HRTS to determine project suitability for inclusion in the study.

Specifics regarding type and area of infilling were typically obtained from the Authorization issued by DFO. If not provided, proposal sketches and case file notes were used to estimate these values. In some cases, the habitat biologist assigned to a particular case file was contacted in order to obtain or clarify information.

3.2 CASE STUDY ANALYSIS

3.2.1 Desktop Review of Case Studies

A total of 18 infilling projects were chosen by DFO for detailed evaluation of the effects of infilling on existing nearshore fish habitat conditions. Projects were selected based on the availability of sufficient documentation for utilizing HAAT, with preferred project files containing descriptions of both pre- and post-development site conditions.

The HRTS database, hardcopy files, and information from habitat biologists were used as needed to obtain the following:

- site location (particularly for AEC case studies)
- project scope
- documentation pertaining to pre- and post-development site conditions (to be used for the HAAT analysis)
- site photos that would indicate pre-, during, and post-development conditions;
- location and size of infilling
- compensation requirements
- monitoring information (i.e., during and post-construction monitoring reports).

In the absence of sufficient information to complete the HAAT analysis for the detailed assessment portion of the study, the assessment was completed using best possible estimates of site conditions based on an interpretation of available information.

Case file information was assembled to create a simplified map of the area showing composites of all physical changes being proposed by the development application. Predicted changes in the pre- and post-development scenario (such as depth, substrate type, and cover) were obtained and illustrated to determine the areas that remained unchanged or that changed. All affected habitat areas (LOSS, MODD, MODI, COMM, and COMC) were identified as polygons and assigned ID numbers to delineate the salient features in the analysis before and after construction (refer to Appendix B to review completed analysis by case study).

The case file information for the pre- and post-development scenario was then categorically entered into the HAAT worksheet (refer to Appendix A) for analysis. Polygon ID numbers, area of each polygon, the type of effect imposed, and required habitat parameters were input into the worksheet.

Some areas were not directly altered by project construction but were anticipated to change with time. For example, changes in vegetative cover caused by changes to local wave exposure from the wind shadow effect of new construction. These impacts were considered indirect and assigned the indirect modification habitat type (MODI). For sites where MODI applications were used, the analysis includes a condition index that requires that the default values of HAAT be altered to reflect indirect effects on the project (Minns et al. 2001). The introduction of the condition index is used to properly account for altered habitat conditions on the leeward or windward side of an imposing structure over time. Habitat at leeward and windward locations are affected as a result of sheltering or increased wave exposure respectively (Minns et al. 2001), and therefore, if applicable, must be incorporated to accurately determine effects of shoreline development (W.F. Baird & Associates 1996). For all sites where a detailed analysis was completed, results of HAAT are illustrated both with and without the condition index to enable a comparison of both scenarios (Appendix B.).

3.2.2 Field Verified Case Studies

Suitable project sites were selected from a number of shoreline infilling projects located exclusively within the Nottawasaga Bay basin (i.e., Georgian Bay). A total of 12 sites were identified; all had been issued Authorizations by DFO.

Case study information was obtained using HRTS and hard copy case files that provided, to varying degrees, a description of the pre-development site conditions. Once appropriate information was collected, an on-site assessment of each project was completed to determine the following:

1) Had the project been implemented?
2) Had the project been implemented in accordance with the Authorization?
3) Had a compensation plan been implemented?
4) Had the compensation plan been implemented in accordance with the Authorization?

The site assessment collected measurements of the size of installed structures (such as the width, height, length, and side slopes of a rock groyne or armourstone revetment), distances of structures in relation to the high water line (or to each other), substrate conditions, water depths, and construction material. Notes were made regarding general site conditions. Measurements were compared with those predicted in the case file or in the Authorization to ascertain compliance with any of the four components above. Field validation confirmed that at 4 of the 12 sites construction had not been initiated. The HAAT analysis was conducted on the 8 projects that were completed.

Photographs of site conditions were collected from various vantage points to document site conditions for the post-development scenario. These photographs are provided for each case study in Appendix B. When available, pre-development site photograpns were used to compare conditions of the project site before and after construction.

For comparison with the analysis completed by DFO, AEC used HAAT to demonstrate results of the expected condition in the pre- and post-development scenario assuming project compliance (based upon a case file review), in addition to the actual conditions observed in the field (from field verification). The expected condition represents an analysis of the effects of development had the project been implemented in accordance with the construction plan in the case file, and did not incorporate results of the field assessment. Field assessment information was used to calculate results for the actual post-development condition, and a combination of field and case file data were used to ascertain pre-development site conditions. Consequently, AEC's analyses of study sites are presented from both an expected and an actual site condition perspective, necessitating the preparation of two HAAT assessments for each case file studied.

Because field assessments of the pre-development scenario were not possible, numerous assumptions were required to evaluate pre- versus post-development conditions. For instance, in the absence of any descriptors of substrate conditions prior to construction, substrate composition was estimated in the field for similar depth zones of adjacent areas unaffected by development. Extrapolations were made under the assumption that site conditions were subject to the same imposing factors such as wave rush, wind direction, and land use (e.g., seasonal residential waterfront, boat access, beach areas). Additional assumptions regarding the footprint of infilled structures were made, such as the location of the original shoreline prior to infilling. Such assumptions were required in cases where the Authorization indicated a certain area of infilling, but detailed information pertaining to how the area of infilling was determined was not specified in the case file. Also, for AEC case files, no information pertaining to proximity of structures to the high water mark was available, therefore best judgment was used to evaluate the high water line in the field.

In cases where site conditions have changed since project completion as a result of alterations to the shoreline (e.g., increased scouring from wave action, or to the contrary, increased deposition zones), the HAAT analysis of the actual post-development scenario is based upon observed conditions. For example, if the Authorization required that an area be stabilized using gravel, however since project

completion the area has been blanketed by sand, the post-development scenario in the HAAT analysis is represented by sand, even if the gravel had been placed during construction. Using this methodology, the analysis includes the effects of temporal or indirect disturbance as a factor determining viability of fish habitat compensation.

3.2.3 Overall Habitat Losses/Gains

The results from the two groups of case studies were pooled to allow for the analysis of the 26 projects for which a detailed analysis using HAAT was completed. An analysis of paper-reviewed versus field-verified projects was conducted. For those sites where MODI was used to reflect habitat changes resulting from wind shadow, HAAT results are presented both with and without the use of the condition index for comparison.

Two ratios were used as the primary means of assessing HAAT results:

1) The ratio of pre- versus post-WSAs was expressed as a percentage. Values less than 100% indicate a net loss.

2) The ratio of the total of all non-loss area (MODD + MODI + COMM + COMC) to areas infilled and consequently lost (LOSS) was expressed as a percentage. These ratios were used to assess the total scope of an infilling project. When the assessment included indirectly affected areas, HAAT results with and without a condition index were summarized and paired analyses were prepared.

The field validation of site conditions after construction offered the opportunity to evaluate project success in two ways: partially on the basis of the HAAT analysis, and also by the degree of compliance, unlike the measurement of success documented by Lange et al. (2001). Projects deemed most successful were those that achieved NNL or improved the productive capacity of fish habitat. This could be achieved even when the project was not in compliance with conditions of the project (typically identified in the Authorization). Under this premise, projects deemed most successful satisfied both the following criteria:

1) The HAAT analysis of the expected condition indicated that the project would result in a net gain of the productive capacity of fish habitat.

2) The entire project, including the compensation plan, was implemented in accordance with the Authorization, and therefore compliance was satisfied.

4.0 RESULTS AND DISCUSSION

4.1 REFERRAL SUMMARY 1997 – 2001.

Between 1997 and 2001, the total number of projects involving in-water works that were referred to DFO in Ontario by local Conservation Authorities, the Ontario Ministry of Natural Resources, and the public was 8,569. DFO issued a Letter of Advice (LOA) for

4,523 projects, or 53% of the total received in this 5-year period, advising them how to fulfill their construction requirements without anticipated harmful impacts to fish habitat (Figure 2).

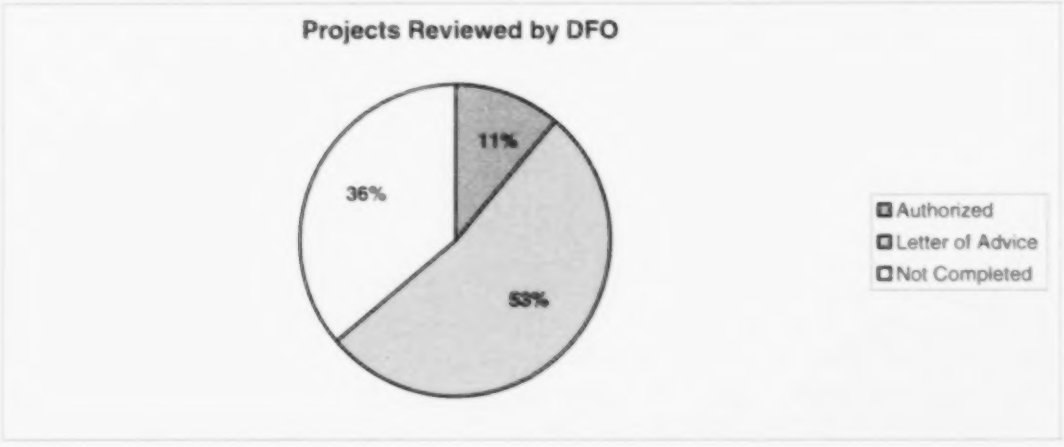

Figure 2. Estimated status of 8,569 projects received by Fisheries and Oceans in Ontario between 1997 and 2001 calculated using the number of Authorizations and Letters Of Advice issued in this time period. NOTE: Values are only estimates, not to be referenced.

A total of 959 projects, or 11%, were authorized for the 'Harmful Alteration, Disruption or Destruction' (HADD) of fish habitat under Section 35 of the *Fisheries Act*. The remaining projects were not completed as proposed due to a number of reasons, including rejection of project design by DFO habitat biologists and cancellation by the proponent prior to project implementation (Figure 2).

A general breakdown of the categories for authorized projects is illustrated in Figure 3. The majority of infilling projects are captured within the category of instream works (47%), followed by shoreline works (24%). Results of the HRTS database search also revealed that 20% (i.e., 187) of the total number of authorized projects in OGLA between 1997 and 2001 involved infilling of fish habitat. A further breakdown of the 187 authorized infilling projects revealed that 9% were instream filling and 11% were shoreline stabilization projects. Together, these projects resulted in over 100,000 m^2 of fish habitat loss (Table 1). Thirty-four percent of the projects, those with an infill area greater than or equal to 200 m^2, accounted for 93% of the habitat loss (97,467 m^2) (Table 1). A few projects involved infilling thousands of square meters and included ferry improvements, marina developments, and quarry loading dock expansions. The majority of projects (66%) involved infill areas of less than 200 m^2.

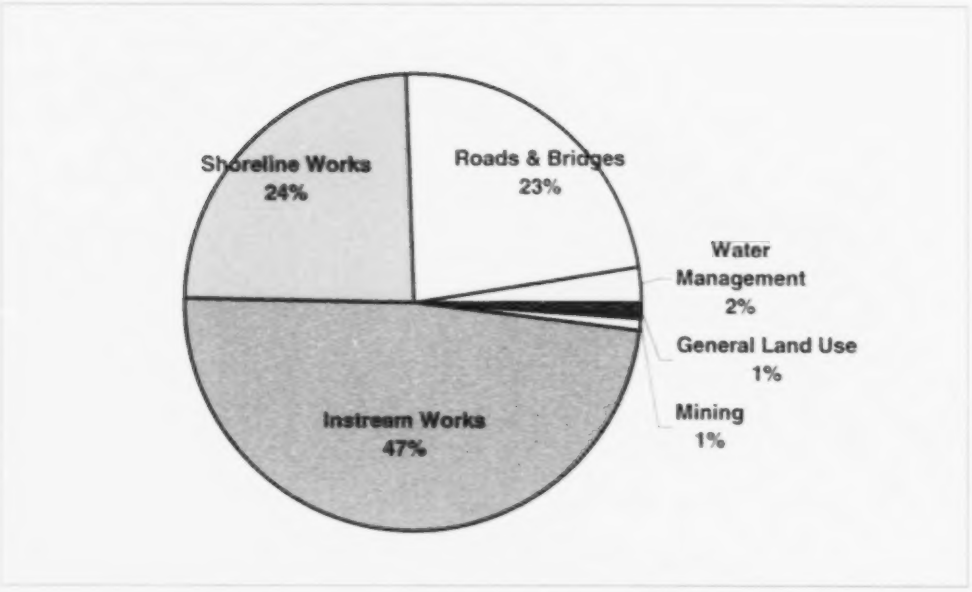

Figure 3. Breakdown of habitat referrals in Ontario receiving Section 35 Authorizations between 1997 and 2001 by category based on a total of 8,569 projects received by Fisheries and Oceans in this time period.

The majority of infilling projects involved in-water works on rivers and creeks, making up 46% of the projects authorized in this 5-year period. The remaining projects were divided between the Great Lakes (28%), inland lakes in Ontario (23%), and ponds and reservoirs (2%) (Figure 4).

Table 1. Number of projects authorized for infilling in the Ontario-Great Lakes Area between 1997 and 2001 and the area of infilling (m^2) involved.

	Infill Area (m^2)		
Project Status	< 200 m^2	>= 200 m^2	Total
Number of Projects	123	64	187
Total Area of Infilling (m^2)	7,471	97,467	104,938

Size of infilling on the Great Lakes shores ranged from 0 to 6,000 m^2, with 26% of projects resulting in less than 50 m^2 and 60% resulting in less than 200 m^2 infill area (Figure 5). Of the 53 projects authorized for infilling in the Great Lakes, 41 were shoreline stabilization projects (e.g., breakwalls, retaining walls, etc.), involving some form of shoreline stabilization structure. Revetments (34%) were the preferred method for stabilization projects within the Great Lakes when compared to vertical retaining walls or groynes (Figure 6).

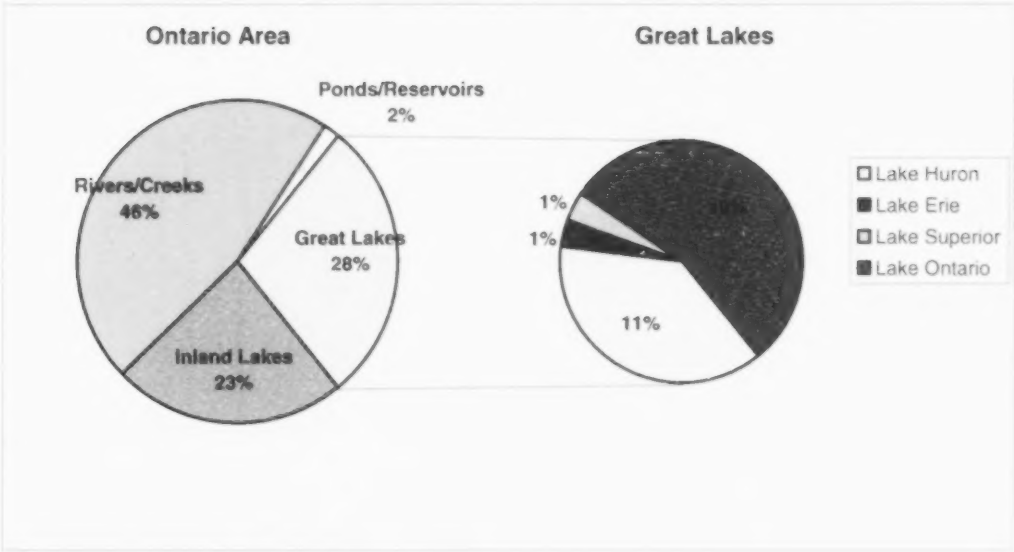

Figure 4. Percentage of infilling projects in Ontario authorized between 1997 and 2001 showing type of water body. This is further broken down by lake for the Great Lakes.

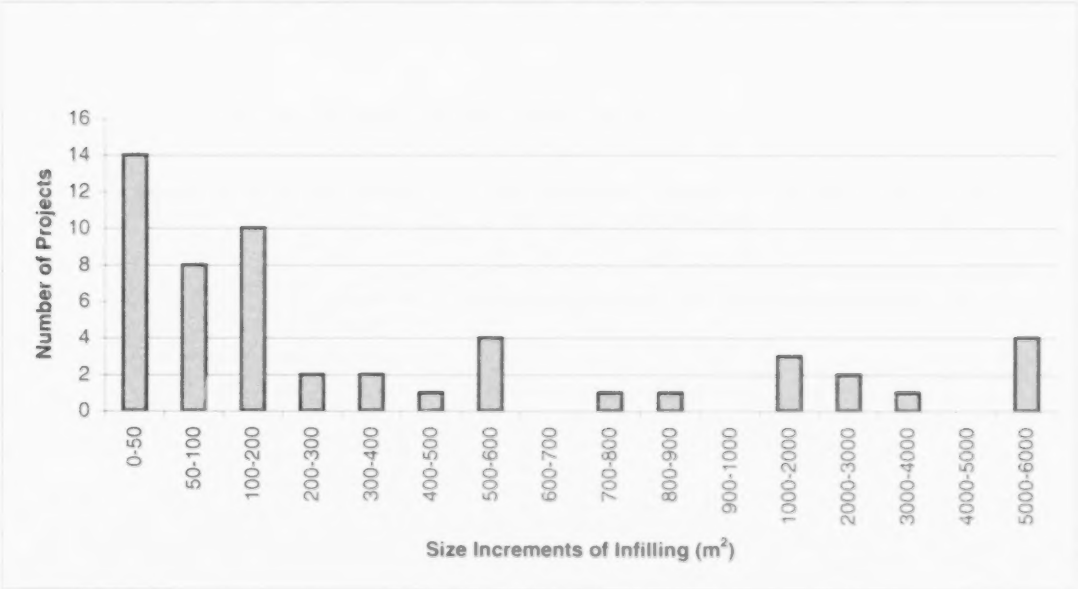

Figure 5. Size of infill (m^2) for infilling projects receiving Section 35 Authorization in the Ontario-Great Lakes Area between 1997 and 2001.

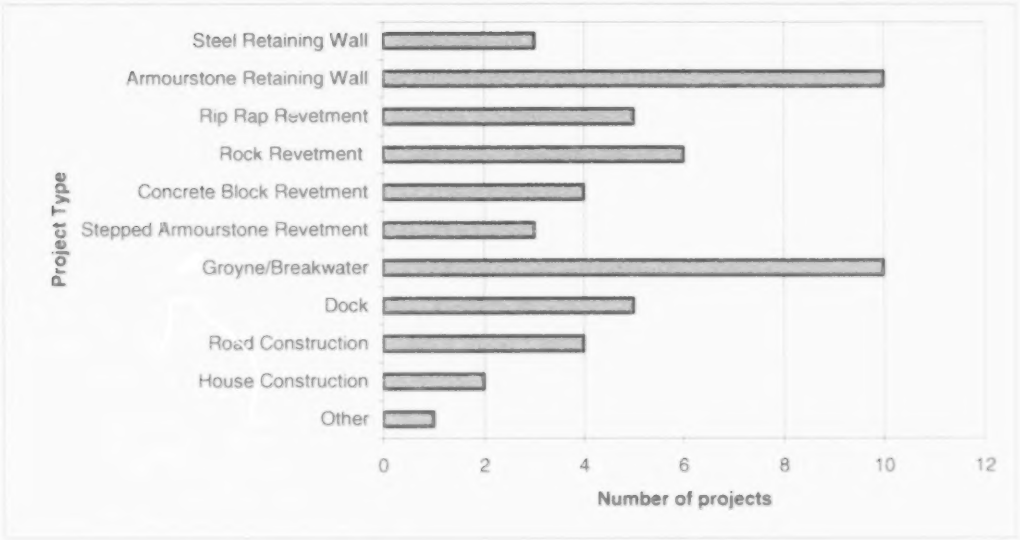

Figure 6. Project type for infilling projects receiving Section 35 Authorization in the Ontario-Great Lakes Area between 1997 and 2001.

4.2 CASE STUDY ANALYSIS

The following 26 case study descriptions represent a subset of the 187 infilling and shoreline alteration projects authorized in OGLA between 1997-2001 (see Figure 7 for a map of case study locations). Cases 1 - 18 represent those cases where the analysis was completed based on the predicted outcome of the project using the case file review exercise. For cases 19 - 26, field studies were completed to validate the expected condition for which the HAAT analysis was completed. In these cases the HAAT was run twice: once for the expected, or predicted scenario, and secondly to evaluate the project subsequent to field validation of post-development conditions.

Results of the detailed analyses are shown in Appendix B, from which the following summary results were derived. In cases where indirect effects are involved, project summaries are given for the scenario applying the indirect effects. Table 2 summarizes the areas altered by development and lists the WSAs for all projects used in the HAAT analysis. Net losses/gains of the productive capacity of fish habitat for each project are summarized in Table 3, showing the net loss/gain specific to each fish life stage and fish thermal/feeding group.

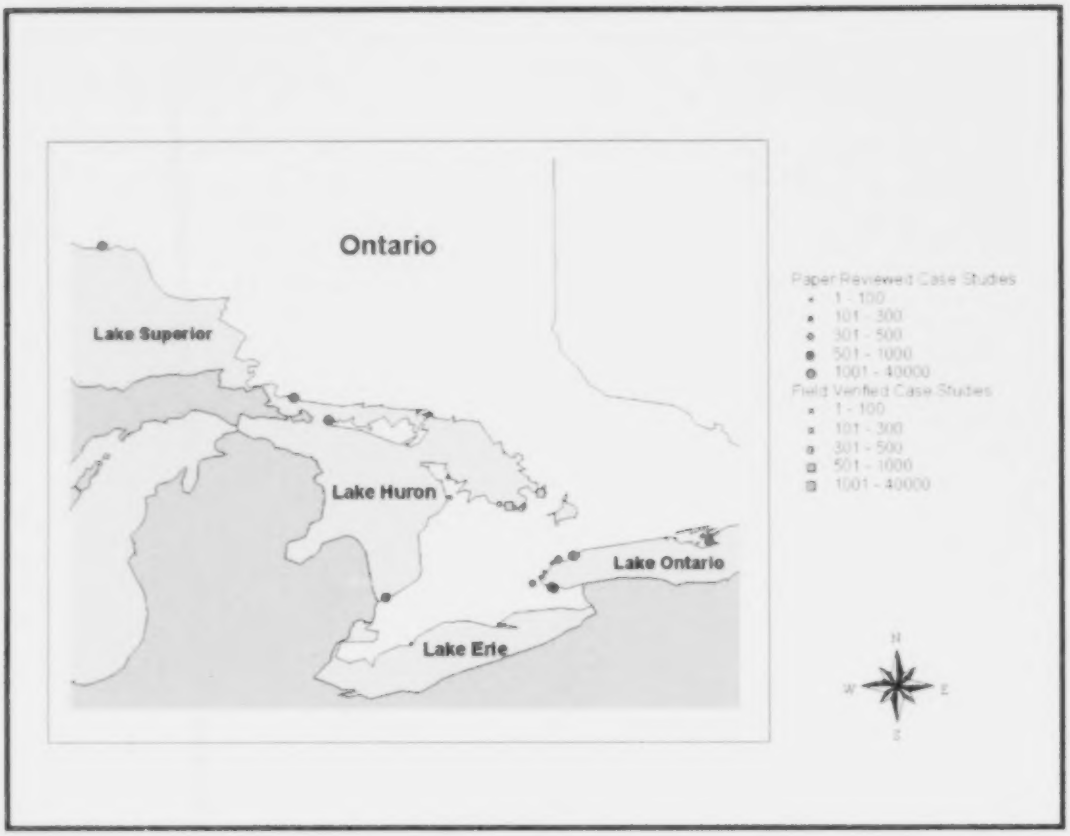

Figure 7. Geographic distribution of case studies in OGLA by size of infill (m^2).

Case 1. Shoreline Protection: Scarborough, Lake Ontario

The project involved the infilling of over 38,000 m^2 of fish habitat. Compensation for this HADD included approximately 10,000 m^2 of habitat enhancement features. The result of the HAAT analysis indicated that the project resulted in a large net loss of the productive capacity of fish habitat. Areas modified directly for project construction and for compensation heightened the effects of the habitat loss caused by infilling, while the areas modified indirectly acted to offset the loss. Fish habitat for YOY was the most impacted from this loss, with coldwater fish habitat being more affected than the coolwater and warmwater nursery habitats. Coldwater piscivore adult habitat was not present in either the before or after project construction conditions.

Case 2. Infilling, Retaining Wall: Long Point, Lake Erie

The project involved the infilling of 40 m^2 of fish habitat. Compensation for the HADD included approximately 80 m^2 of habitat enhancement features. The result of the HAAT analysis indicated that the areas modified and created for compensation acted to offset the loss due to infilling, and the project resulted in a net gain in the productive capacity of fish habitat, with all habitat types experiencing a gain.

Spawning habitat achieved the greatest net gain, and coldwater fish habitat experienced a larger gain over coolwater and warmwater habitats. Coldwater piscivore adult habitat was not present in either the before or after project construction conditions.

Case 3. Dredging, Infilling and Blasting: Town of Bruce Mines, Lake Huron

The project involved the infilling of 8,000 m^2 of fish habitat and the dredging of 15,000 m^2. Compensation for this HADD included approximately 26,000 m^2 of habitat enhancement features. The results of the HAAT analysis indicated that the compensation measures were not sufficient to offset the loss, and the project resulted in the net loss of the productive capacity of fish habitat. Areas modified directly for project construction heightened the adverse effects caused by infilling, while the areas modified for compensation acted to offset some of the loss.

Spawning habitat experienced a net gain, and both adult and YOY habitats experienced a net loss. Coldwater habitat experienced a net gain, while coolwater and warmwater fish habitats experienced a net loss of the productive capacity of fish habitat in the area.

Case 4. Shoreline Stabilization: Grimsby, Lake Ontario

The project involved the infilling of over 2,800 m^2 of fish habitat. Compensation for this HADD included just over 300 m^2 of habitat enhancement features. The result of HAAT analysis indicated that the compensation measures were not sufficient to counteract this loss, and the project resulted in the net loss of the productive capacity of fish habitat. Both the areas modified directly for project construction and compensation heightened the negative effects caused by infilling.

Adult fish habitat experienced a slight gain, while both the spawning and YOY habitats experienced a net loss. Warmwater habitat experienced a larger net loss over coolwater and coldwater habitats. Coldwater piscivore adult habitat was not present in either the before or after project construction conditions.

Case 5. Breakwater Construction: Prince Edward County, Lake Ontario

The project involved infilling 740 m^2 of fish habitat, with compensation for this HADD totaling 487 m^2 of fish habitat enhancing features. The HAAT analysis indicated a minimal net loss in the productive capacity of fish habitat. The areas modified directly for project construction heightened the negative impacts of infilling, while the areas modified indirectly and modified for compensation acted to counteract the loss.

Adult fish habitat experienced a net loss in its productive capacity of fish habitat, while YOY and spawning habitats experienced a net gain. Coldwater habitat experienced a net gain in the productive capacity of fish habitat, while both coolwater and warmwater habitats experienced a loss.

Case 6. Infilling - Railway Embankment Stabilization: Tunnel Bay, Lake Superior

The project resulted in the infilling of over 1,900 m^2 of fish habitat. The result of the HAAT analysis indicated that the area modified directly for project construction

heightened the damaging effects caused by infilling, and with no compensation to counteract this HADD, the project resulted in the net loss of the productive capacity of fish habitat.

Adult fish habitat was the most impacted from this loss, with coolwater fish habitat being more affected than the coldwater or warmwater habitats.

Case 7. Shoreline Stabilization (Infill): Hamilton Harbour, Lake Ontario

The project involved the infilling of 390 m^2 of fish habitat, with no compensation to offset the loss of habitat or enhance existing habitat conditions. The result of the HAAT analysis indicates that, although the area modified directly for project construction acted to offset the HADD, the project still resulted in the net loss of the productive capacity of fish habitat.

Spawning fish habitat was the most impacted from this loss, with coldwater habitat being more affected than the coolwater and warmwater habitats.

Case 8. Shoreline Stabilization: Burlington, Lake Ontario

The project involved the infilling of 260 m^2 of fish habitat. Compensation for this HADD included approximately 48 m^2 of fish habitat enhancement features. The result of the HAAT analysis indicated that the positive effects of the areas modified directly for construction and areas modified for compensation were not sufficient to offset this HADD, and the project resulted in the net loss of the productive capacity of fish habitat.

Spawning fish habitat was the most impacted from the loss, with warmwater fish habitat being more affected than the coolwater and coldwater habitats. Coldwater piscivore adult fish habitat was not present in either the before or after project construction conditions.

Case 9. Shoreline Stabilization: Hallowell Township, Bay of Quinte

The project involved infilling of over 100 m^2 of fish habitat. Compensation for this HADD included approximately 60 m^2 of habitat enhancement features. The result of the HAAT analysis indicated that the compensation measures were not sufficient to counteract this loss, and the project resulted in a net loss of the productive capacity of fish habitat. Areas modified directly for project construction and modified for compensation heightened the effects caused by the HADD.

YOY fish habitat was the most impacted from this loss, with coolwater fish habitat being more affected than the coldwater and warmwater habitats. Coldwater piscivore adult fish habitat was not present in either the before or after project construction conditions.

Case 10. Shoreline Stabilization, Steel Sheet Wall: Small Craft Harbours, Georgian Bay

The project involved the infilling of almost 30 m^2 of fish habitat. Compensation for this HADD included 16 m^2 of habitat enhancement features. The result of the HAAT

analysis indicated that the compensation measures were not sufficient to counteract this loss, and therefore the project resulted in the net loss of the productive capacity of fish habitat.

Spawning habitat was the most impacted from this loss, with coldwater fish habitat being more affected than the coolwater and warmwater habitats.

Case 11. Infilling: Halton County, Town of Oakville, Lake Ontario

The project involved the infilling of 40 m^2 of fish habitat. No compensation for this HADD was involved, and the HAAT analysis indicated that the project resulted in the net loss of the productive capacity of fish habitat. The area modified directly for project construction increased the negative impacts caused by infilling.

Spawning habitat was the most impacted from this loss, with coldwater fish habitat being more affected than the coolwater and warmwater habitats. Coldwater piscivore adult fish habitat was not present in either the before or after project construction conditions.

Case 12. Infilling: Mississauga, Peel Township, Credit Valley, Lake Ontario

The project involved the infilling of 40 m^2 of fish habitat. Compensation for this HADD included an area equal in size of habitat enhancement features. The result of the HAAT analysis indicated that the compensation measures were not sufficient to counteract this loss, and the project resulted in a net loss of the productive capacity of fish habitat. Both the areas constructed to compensate for the HADD and the areas modified directly for project construction heightened the negative impacts caused by infilling.

Spawning fish habitat was the most impacted from this loss, with warmwater fish habitat being more affected than the coolwater and coldwater. Coldwater piscivore adult fish habitat was not present in either the before or after project construction conditions.

Case 13. Armourstone groyne: City of Sarnia, Bright's Grove, Lake Huron

The project involved the infilling of over 500 m^2 of fish habitat. No compensation for this HADD was involved, thus the result of the HAAT analysis indicated that the project resulted in the net loss of the productive capacity of fish habitat. The area modified directly for project construction increased the size of the HADD, while the areas modified indirectly from construction acted to offset the negative impact.

Spawning fish habitat was the most impacted from the loss, with coolwater fish habitat being more affected than the coldwater and warmwater habitats.

Case 14. Shoreline Protection: Toronto, Lake Ontario

The project involved the infilling of approximately 430 m^2 of fish habitat. Compensation for this HADD included approximately 70 m^2 of fish habitat enhancement features. The result of the HAAT analysis indicated that the compensation measures were sufficient to counteract this loss, and the project resulted in a net gain of the productive capacity of

fish habitat. Both the areas altered for compensation and areas modified directly from project construction worked to offset the loss.

Spawning fish habitat benefited the most from this gain, with coldwater fish habitat improving more than the warmwater and coolwater habitats.

Case 15. Shoreline Protection: Town of Grimsby, 5th Street and Victoria Terrace, Lake Ontario

The project involved the infilling of over 750 m^2 of fish habitat. Compensation for this HADD included approximately 170 m^2 of habitat enhancement features. The result of the HAAT analysis indicated that the compensation measures were not sufficient to counteract this loss, and the project resulted in the net loss of the productive capacity of fish habitat. The areas modified directly for project construction and areas modified for compensation increased the size of the HADD, while the area modified indirectly from construction worked to offset the negative impacts.

Spawning fish habitat was the most impacted from this loss, with warmwater fish habitat being more affected than the coolwater and coldwater habitats.

Case 16. Dock, Infill: Cigar Island, Amabel Township, Lake Huron

The project involved the infilling of 12 m^2 of fish habitat. Compensation for this HADD included 14 m^2 of habitat enhancement features. Results of the HAAT analysis indicated that the compensation measures increased the size of the HADD. The area modified indirectly from project construction worked to counteract the loss but was not sufficient, and the project resulted in the net loss of the productive capacity of fish habitat.

YOY fish habitat was the most impacted from this loss, with coolwater fish habitat being more affected than the coldwater and warmwater habitats.

Case 17. Infill: Dawson Township, Mississagi Strait, Lake Huron

The project involved the infilling of over 7,500 m^2 of fish habitat. Compensation for this HADD included approximately 1,200 m^2 of habitat enhancement features. The result of the HAAT analysis indicated that the compensation measures were not sufficient to counteract this loss, and the project resulted in a large net loss of the productive capacity of fish habitat. The areas modified directly from project construction heightened the effects of habitat loss, while the areas of compensation and areas modified indirectly worked to offset a portion of the impacts from infilling.

Spawning fish habitat was the most impacted from the loss, with coldwater fish habitat being much more affected than the coolwater and warmwater habitats.

Case 18. Shoreline Protection: Town of Grimsby, Lake Ontario

The project involved the infilling of over 50 m^2 of fish habitat. Compensation for this HADD included 40 m^2 of habitat enhancement features. The result of the HAAT

analysis indicated that the areas of compensation and areas modified directly from project construction worked to offset the impacts of the HADD, and the project resulted in the net gain of the productive capacity of fish habitat.

Spawning fish habitat benefited the most from this gain, with coldwater fish habitat experiencing a larger gain than warmwater and coolwater habitats. Coldwater piscivore adult and coolwater piscivore YOY fish habitats were not present in either the before or after project construction conditions.

Case 19: Concrete Block Retaining Wall: Lower Nottawasaga River, Wasaga Beach

Expected Scenario: The project included the construction of a concrete block retaining wall resulting in the infilling of 42 m^2 of fish habitat. Compensation for the loss of this habitat included shoreline plantings and habitat enhancements totaling an area of 22.8 m^2. Results of the HAAT analysis indicated that compensation measures increased the size of the HADD resulting in the net loss of fish habitat for all thermal groups and life stages, with coolwater YOY non-piscivores most strongly affected.

Actual Scenario: In actuality, the HADD was slightly greater than anticipated due to increased area of infilling. However, the area of compensation was also increased to offset impacts to habitat. Using the HAAT analysis, compensation efforts were not sufficient to offset negative impacts, and all thermal groups and life stages were impacted. Similar to the expected condition, coolwater non-piscivores YOY were the most largely affected.

Case 20: Shoreline Stabilization: Lower Nottawasaga River, Wasaga Beach

Expected Scenario: The project resulted in the infilling of 20 m^2 of fish habitat. Compensation for the HADD was 16 m^2 of substrate enhancement features. Results of the HAAT analysis indicated that compensation measures were not significant and contributed to the negative impacts to fish habitat. Coolwater non-piscivores of all life stages were most strongly affected by the development.

Actual Scenario: The field observations indicate that the site has not been fully restored. Both the expected and actual condition represent net losses for all thermal classes and age groups. However, negative effects in the actual scenario are slightly greater than that of the expected. YOY non-piscivores were impacted more than adults or spawners in both the expected and actual scenario.

Case 21: Retaining Wall: Lower Nottawasaga River, Wasaga Beach

Expected Scenario: The project involved the infilling of 15 m^2 of fish habitat, to be compensated for at a 1:1 ratio through the placement of stone for habitat enhancement. The analysis indicated that the compensation measures contributed to the HADD and inadequately replaced habitat lost, resulting in negative impacts to all fish life stages and thermal groups. YOY fish habitat was impacted the most, with coolwater species being affected more than cold or warmwater species groups.

Actual Scenario: The project was completed to specifications. However, the HAAT analysis indicated a net loss in the productive capacity of fish habitat as described for the expected scenario due to inadequate compensation for the HADD.

Case 22: Cedar Post Retaining Wall, Lower Nottawasga River, Wasaga Beach

Expected Scenario: The proposed retaining wall resulted in the infilling of 54 m^2 of fish habitat. Compensation for this loss was to be provided using habitat enhancement features in an area totaling 18 m^2. The HAAT analysis indicated a net loss of the productive capacity of fish habitat for all fish life stages and thermal groups. YOY and adult coolwater piscivore habitats were the most impacted from this loss.

Actual Scenario: The project was completed. However, the materials and rock size used for compensation were not as specified in the compensation plan. The HAAT analysis indicated a net loss in fish habitat, with compensation efforts heightening the resulting loss. Affected habitat remained consistent with the expected scenario.

Case 23: Construction of Breakwall: Collingwood, Georgian Bay

Expected Scenario: The project involved the infilling of 27 m^2 of fish habitat. Compensation for the loss included the construction of rock rubble habitat structures to diversify habitat conditions, totaling an area of 47 m^2. The HAAT analysis indicated that the compensation measures were sufficient to counteract the loss, and the project resulted in a net gain of the productive capacity of fish habitat. Both the areas altered for compensation and the areas modified indirectly from project construction worked to offset the loss. Habitat improvements were expected for all spawning types and thermal groups, with spawning warmwater, coolwater, and coldwater non-piscivores expected to experience the highest net gain. Including indirect effects into the HAAT analysis increased the potential net gain for fish productivity.

Actual Scenario: The project was completed. However, areas of compensation and rock size used were not consistent with the expected scenario. Consequently, the HAAT analysis indicated that compensation measures were not sufficient to counteract the loss. The project in actuality resulted in the net loss of fish habitat productivity, despite slight improvements in the net results as a result of compensation. YOY coldwater piscivores were the most impacted from this loss, with non-piscivores of all thermal groups and life stages impacted as well. Although applying the condition index functioned to reduce negative impacts, the outcome remained a net loss.

Case 24: Construction of Rock Groyne Extension: Nottawasaga Bay, Georgian Bay

Expected Scenario: The project resulted in the infilling of only 4 m^2. However, due to proposed dredging activities, areas directly modified represented the area to be most affected by development. Compensation for the HADD included rock placement and improved circulation patterns, totaling an area of 9.6 m^2. Results of the HAAT analysis indicated that compensation measures and areas modified directly adequately

counteracted losses, with improvements heightened when the condition index was applied. Spawning coldwater and warmwater non-piscivores were the only groups negatively affected by development, with the highest gain experienced by coldwater YOY and spawning piscivores.

Actual Scenario: The expected construction plan differed slightly from the expected scenario, resulting in increased areas of directly modified habitat. Consequently, using HAAT, the project created a net loss of productive capacity of fish habitat. Areas modified directly, indirectly, and areas of compensation, all functioned to heighten the effects of habitat losses, with spawning habitat of non-piscivores (in all thermal groups) being most impacted from habitat alterations.

Case 25: Modification of Existing Groyne: Collingwood, Georgian Bay

Expected Scenario: The project involved the infilling of 22.7 m^2 of fish habitat. However, due to proposed dredging activities, areas directly modified represented the areas most affected by development. Compensation for the HADD included the facilitation of water circulation and habitat enhancement measures, totaling an area of 15 m^2. The HAAT analysis indicated that the proposed construction plan was sufficient to counteract the HADD, resulting in increased habitat production for all groups except for spawning non-piscivores in all three thermal groups.

Actual Scenario: The project was completed with some variability in the rock size used for the site stabilization. Interestingly, the compensation for the HADD adequately offset the loss, with a heightened gain in fish habitat productivity resulting from areas directly modified by development. The habitat most positively affected from the gain was YOY, with coolwater non-piscivores experiencing a slightly higher gain than coldwater piscivores.

Case 26: Shoreline Protection: Sturgeon Bay, Waubaushene, Georgian Bay

Expected Scenario: The project involved a small area of infill totaling 4 m^2. To compensate for the loss, compensation included the creation of habitat in a 3 m^2 area previously inaccessible to fish. The results of the HAAT analysis indicated that the expected scenario resulted in a net loss of fish habitat, albeit small, with all life stages and thermal groups negatively impacted.

Actual Scenario: The project was completed and a larger area of compensation was implemented. However, results of the HAAT analysis indicate that compensation measures were not sufficient to adequately replace lost habitat, resulting in an extremely low overall net loss. Coldwater spawning habitat was positively affected by development, however most other groups indicated losses.

Table 2. Summary of areas modified for project construction (LOSS, MODD, and MODI) and compensation (COMM and COMC) and weighted suitable areas (WSA) used in HAAT analysis for each case study.

Case No.	Analysis Type	Size of Work Area (LOSS+MODD) (m^2)	Areas (m^2)					WSA m^2 Equivalency			
			LOSS	MODD	MODI	COMM	COMC	PRE LOSS	PRE Total	POST COMC	POST Total
1	A	38433	34878	3555	0	10274	0	15631.8	20976.2	0	2370
1	B	38433	34878	3555	330	10274	0	15631.8	19052.2	0	1784.6
2	A	40.5	40.5	0	0	17	65.1	9.2	13.1	14.9	19.2
3	A	23000	8000	15000	0	26425	0	1243.1	6648.1	0	5228.2
4	A	2879.6	2232.5	647.1	0	316.35	0	118.3	169	0	125.9
5	A	739.9	283.7	456.2	0	0	487	64.5	225.7	73	183.4
5	B	739.9	283.7	456.2	308.8	0	487	64.5	167.7	73	167.2
6	A	1967	945	1022	0	0	0	112.8	267.3	0	127.7
7	A	390	284.7	105.3	0	0	0	84.7	116	0	32
8	A	260.5	240.5	20	0	48	0	22.5	28.7	0	10.5
9	A	116.8	85.2	31.6	0	60	0	28.2	57.8	0	21.7
10	A	28.4	28.4	0	0	16	0	9.3	15.2	0	6.5
11	A	40	34.4	5.6	0	0	0	9.6	11.2	0	0.6
12	A	40.5	29	11.5	0	39.4	0	11.1	30.5	0	8.6
13	A	525	255	270	0	0	0	121.5	458.6	0	225.6
13	B	525	255	270	432	0	0	121.5	337.2	0	215.9
14	A	432	170	262	0	73	0	5.3	15.1	0	36.6
15	A	723.1	412.6	310.5	0	171	0	124.6	298.1	0	94.4
15	B	723.1	412.6	310.5	111.4	171	0	124.6	235.6	0	76.3
16	A	12	12	0	0	14	0	5.8	51.2	0	40.4
16	B	12	12	0	80.52	14	0	5.8	34.9	0	25.9
17	A	7585	5988	1597	0	1235	0	834.2	1426.2	0	518.5
17	B	7585	5988	1597	188	1235	0	834.2	1213	0	453.7
18	A	55	36	19	0	40.6	0	2.1	5.5	0	8.3
19Ex	A	42	42	0	0	22.8	0	20.8	32.1	0	2.9
19Ac	A	47.3	39.4	0	0	32.8	0	19.5	35.7	0	0.4
20Ex	A	30.4	20	10.4	0	16	0	9	32.1	0	2.9
20Ac	A	38.2	28.4	9.8	0	35.6	0	12.7	31.7	0	11.3
21Ex	A	15	15	0	0	15	0	7.3	14.6	0	2.8
21Ac	A	14.1	14.1	0	0	15.5	0	6.9	14.5	0	5.3
22Ex	A	54	54	0	0	18	0	26.4	34.5	0	2.6
22Ac	A	47.7	47.7	0	0	15.9	0	23.3	30.4	0	3.4
23Ex	A	40.2	27	13.2	51	47	0	4.7	23.9	17.2	56.2
23Ex	B	40.2	27	8.4	32.6	30.1	0	4.7	17	17.2	54.5
23Ac	A	27	27	0	72.2	36.2	0	11.6	58.1	3.3	40.9
23Ac	B	27	27	0	46.2	23.2	0	11.6	41.3	3.3	39.1
24Ex	A	516.1	3.1	513	444.8	11.3	0	0.4	132.9	0	180.6
24Ex	B	794	3.1	328.3	284.7	7.2	0	0.4	85.2	0	164
24Ac	A	516.1	3.9	790.1	415.8	9.6	0	1.5	479.1	0	212.9
24Ac	B	794	3.9	505.7	266.1	6.1	0	1.5	307.2	0	207.4
25Ex	A	825.8	22.7	803.1	0	0	0	7.3	281.4	7.6	357.1
25Ac	B	827.4	24.3	803.1	0	0	0	8.3	282.8	9.8	270.8
26Ex	A	2.4	3.8	0	0	0	0	1.2	1.2	0.2	0.2
26Ac	B	3.8	1.2	1.2	0	0	0	0.6	1.2	1	1.1

NOTE:
- A scenario without indirect effect applied
- B scenario with indirect effect applied
- Ex results of HAAT analysis for the expected scenario prior to validating works in the field
- Ac results of HAAT analysis for the actual scenario after validating works in the field

Table 3. Summary HAAT results for case studies showing net loss/gain specific for each life stage and thermal preference. Net change indicates end result after project construction.

Case No.	Analysis Type	Predominant POST Construction Substrate	Warmwater			Coolwater			Coldwater			Net Change
			Spawning	YOY	Adult	Spawning	YOY	Adult	Spawning	YOY	Adult	
1	A	Hard	-	-	-	-	-	-	-	- -	-	-
1	B	Hard	-	-	-	-	-	-	-	- -	-	-
2	A	Soft	+	+	+	+	+	+	+ +	+	+	+
3	A	Mixed	+	-	-	+	- -	-	+ +	-	-	-
4	A	Hard	- -	-	+	+	-	+ +	-	+	-	-
5	A	Mixed	-	-	- -	-	-	-	-	-	-	-
5	B	Mixed	- -	+	-	-	-	-	+ +	+	+	-
6	A	Mixed	+	-	- -	-	-	-	+ +	-	-	-
7	A	Mixed	-	-	-	-	-	-	- -	-	-	-
8	A	Mixed	-	-	-	-	-	-	- -	-	-	-
9	A	Mixed	-	-	- -	-	-	-	-	-	-	-
10	A	Mixed	-	-	-	-	-	-	- -	-	-	-
11	A	Hard	-	-	-	-	-	-	- -	-	-	-
12	A	Mixed	-	-	-	-	-	-	-	- -	-	-
13	A	Soft	-	-	-	-	-	-	-	- -	-	-
13	B	Soft	-	-	-	-	-	-	-	- -	-	-
14	A	Hard	- -	0	+	+	-	+	+ +	+	-	+
15	A	Hard	-	-	-	-	-	-	-	- -	-	-
15	B	Hard	-	-	-	-	-	-	-	- -	-	-
16	A	Soft	-	-	-	-	-	-	-	- -	-	-
16	B	Soft	-	-	-	-	-	-	-	- -	-	-
17	A	Hard	-	-	-	-	-	-	- -	-	-	-
17	B	Hard	-	-	-	-	-	-	- -	-	-	-
18	A	Mixed	-	-	+	+	- -	+	+ +	+	-	+
19Ex	A	Mixed	-	-	-	-	- -	-	-	-	-	-
19Ac	A	Mixed	-	-	-	-	- -	-	-	-	-	-
20Ex	A	Mixed	-	-	-	-	- -	-	-	-	-	-
20Ac	A	Mixed	-	-	-	-	- -	-	-	-	-	-
21Ex	A	Mixed	-	-	-	-	- -	-	-	-	-	-
21Ac	A	Mixed	-	-	-	-	- -	-	-	-	-	-
22Ex	A	Mixed	-	-	-	-	- -	-	-	-	-	-
22Ac	A	Mixed	-	-	-	-	- -	-	-	-	-	-
23Ex	A	Mixed	+ +	+	+	+	+	+	+	+	+	+
23Ex	B	Mixed	+	+	+	+	+	+	+ +	+	+	+
23Ac	A	Mixed	-	-	-	-	-	-	-	- -	-	-
23Ac	B	Mixed	-	-	-	-	- -	-	-	-	-	-
24Ex	A	Mixed	-	+	+	- -	+	+	+ +	+	+	+
24Ex	B	Mixed	+	+	+	- -	+	+	+ +	+	+	+
24Ac	A	Soft	-	-	-	- -	-	-	-	-	-	-
24Ac	B	Soft	-	-	-	- -	-	-	-	-	-	-
25Ex	A	Mixed	-	+	+	- -	+	+	+	+ +	+	+
25Ac	A	Soft	-	+	+	-	+ +	+	- -	+	+	-
26Ex	A	Hard	-	-	-	-	-	-	-	- -	-	-
26Ac	A	Hard	-	0	-	-	-	-	+	- -	-	-

Note: Projects with only analysis type A occur where no indirect effects were involved with project construction.

A	scenario with indirect effect not applied	+	net gain
B	scenario with indirect effect applied	+ +	largest combined net gain (piscivores and non-piscivores)
0	no effect	-	net loss
Hard	bedrock, boulder	- -	largest combined net loss (piscivores and non-piscivores)
Mixed	cobble, rubble, gravel		
Soft	sand, silt, clay		
Ex	Results of HAAT analysis for the expected scenario prior to validating works in the field		
Ac	Results of HAAT analysis for the actual scenario after validating works in the field		

4.3 OVERALL HABITAT LOSSES/GAINS

By combining the two sets of case studies, some overall comparisons and inferences were possible. In addition, through paired analysis, it was possible to look at the differential effects of paper vs. field assessments, and to consider indirect effects where change in wind shadow (WS) altered the exposure of habitats.

Using infill area as a reference point, two patterns were analyzed in the case studies: a) the ratio of post:pre-scenario weighted suitable areas (WSAs), and b) the ratio of all other affected areas (MODD, MODI, COMM, and COMC) to LOSS (= Infill). The plot, by analysis type, of post:pre WSAs ratio (expressed as a percentage) versus infill area was prepared with logarithmic scales to accommodate the wide range of values on both axes (Figure 8). Most cases had ratio values less than 100, and the trend overall was similar regardless of infill size. The type of analysis did not appear to make a big difference, although in general, consideration of WS raised the ratio value.

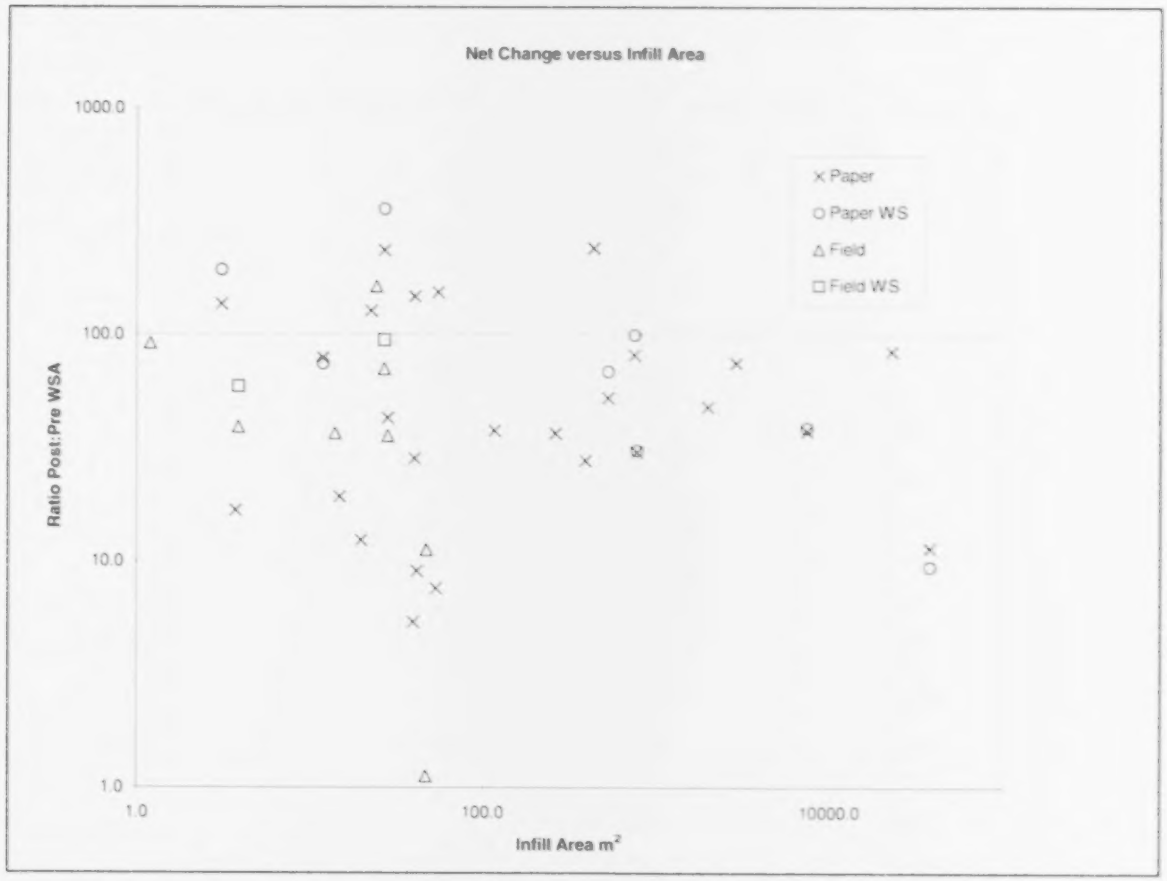

Figure 8. Logarithmic plot of infill area (m^2) versus the ratio of post:pre weighted suitable areas as a percentage. (Ratios greater than 100 indicate a net gain.)

The plot of area ratio as percentage of all other area types to infill (or loss) versus infill area indicated an inverse relationship (Figure 9). Inverse plots of the ratios indicated there was a hyperbolic relationship, with the few very high area ratios for very small infill values being somewhat anomalous. This was consistent with the heterogeneity of the case studies where some involved substantial dredging compared to the infill. The area ratios for analyses where WS was considered were consistently above the corresponding base analysis (either paper or field), reflecting the increased areas involved through indirect effects.

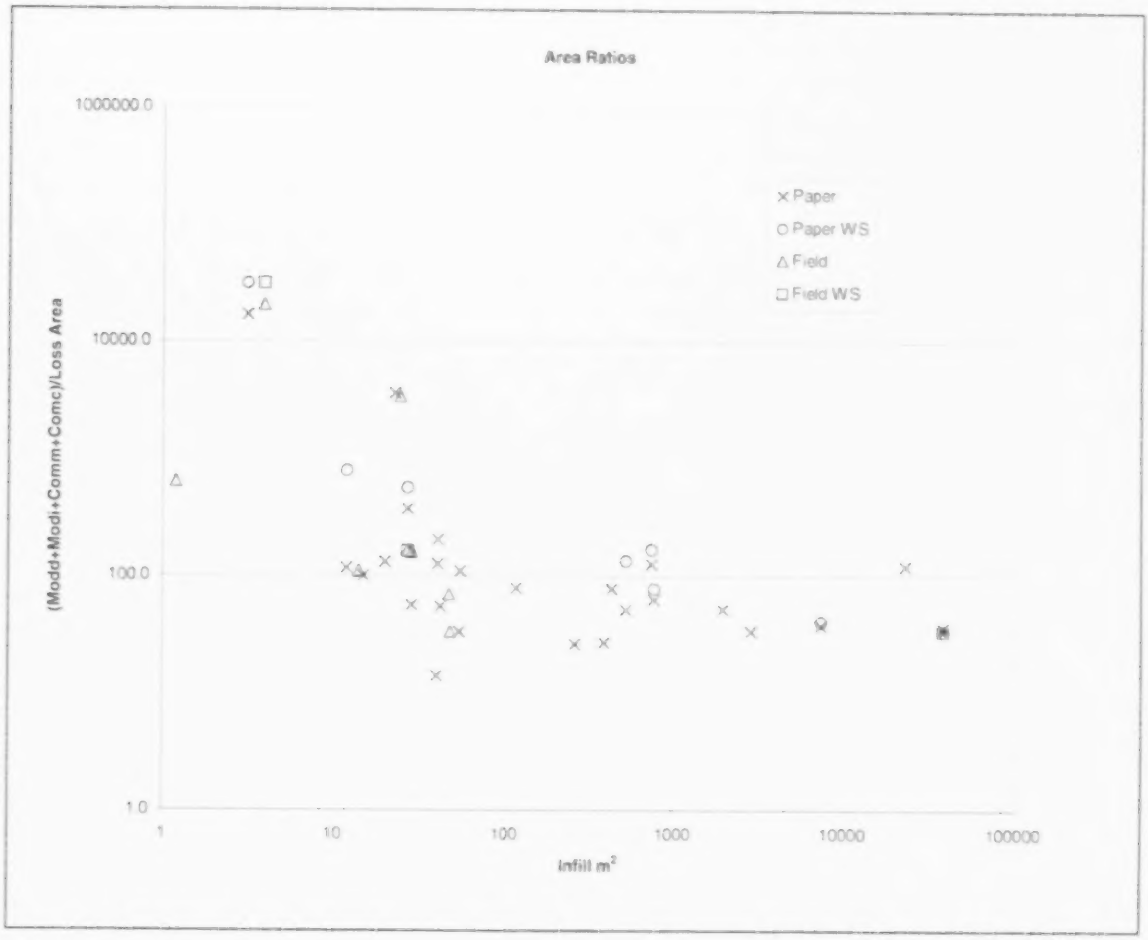

Figure 9. Logarithmic plot showing the ratio of areas (MODD + MODI + COMM + COMC):LOSS versus infill area (m^2).

As the ratios used to assess the case studies varied so much, geometric means were determined to facilitate the comparisons among analysis types (Table 4). For paper-based analyses (n = 26), the mean post:pre WSAs ratio was 42.2 %, corresponding to a 57.8 % net loss. There were 76.9% of cases with a net loss, and the total of other area types (e.g., MODD) was approximately equal to the infill area. In those case studies

where paper analyses were done with and without consideration of WS, the results (n = 8) showed that including indirect effects of wind-wave exposure did improve the post:pre WSAs ratio but only by 8.1%, while the area ratio increased from 159.1 to 275.0. In the Nottawasaga Bay analyses, where both paper and field analyses were performed (n = 8), there was a 2.0% decrease in the post:pre WSAs ratio, while the area ratio increased from 284.8 to 361.2, indicating no real difference in terms of net change. The two field cases where WS was considered showed a considerable gain in the post:pre WSAs ratio of 22.3 %, although these case studies had unusually large non-loss areas.

Table 4. Summary statistics of the case studies showing the geometric mean ratio of post:pre weighted suitable areas, percentage of cases showing a net loss, and the geometric mean of the ratio of areas (MODD + MODI + COMM + COMC):LOSS.

Data set	Sample size (n)	Geometric mean Post:Pre WSAs	Percentage with a Net Loss	Area ratio
Paper only	26	42.2	76.9	98.6
Paper vs. Paper WS				
Paper	8	58.4	75.0	159.1
Paper WS	8	66.5	75.0	275.0
Paper vs. Field				
Paper	8	32.0	87.5	284.8
Field	8	30.0	87.5	361.2
Field vs. Field WS				
Field	2	52.4	100.0	1823.7
Field WS	2	74.7	100.0	2251.3

4.4 TRENDS

The net change in the post-development scenario is, in most cases, significantly higher than that in the pre-development condition. Although only a small subset of project sites were field validated, it is prudent to assume that a proportion of the total number of projects that received Authorizations either were: 1) not implemented, and the degree of infilling in the Great Lakes may be lower than first anticipated; and/or, 2) projects that have been implemented are not complying with fisheries regulations for the protection of fish habitat. Consequently, the actual degree of infilling in the Great Lakes and comparative impacts to the productive capacity of fish habitat in the Great Lakes is much greater than anticipated.

There were no significant increases in the amount of infilling and the variability in HAAT results appears to be a result of unpredicted impacts to areas directly and indirectly modified from development.

5.0 CONCLUSIONS

- Most infills are small, and based on the HAAT cases studies, are unnecessary. Many of the small projects could be completed by placing the structures on the landward side of the land-fish habitat boundary.
- Larger infills should always be required to undergo HAAT assessment.
- The HAAT case studies showed that most projects result in a net loss and that compensation is uncommon. Attempts to offset losses through enhancement of modified areas have often resulted in additional losses rather than gains.
- The HAAT case studies showed that consideration of wind sheltered areas does not usually shift the result from loss to gain, though there is typically some improvement.
- The HAAT case studies showed that similar results were obtained with paper and field assessments.
- The field assessments revealed serious problems regarding compliance with Authorizations. Changes were often made during implementation and were not reported to DFO.

6.0 ACKNOWLEDGEMENTS

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SITE #

PRE-Development Scenario

ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover

POST-Development Scenario

ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed ?

APPENDIX A: HAAT Templates

Depth Zones
0-1
1-2
2-5
5-10
10+

Substrates	cm
bedrock	
boulder	> 25
cobble	17-25
rubble	6.4-17
gravel	0.2-6.4
sand	< 0.2
silt	finer than sand with organic component
clay	
hardpan clay	

Cover
submergent
emergent
no cover

Habitat Types	see page 42 and 12 in MS 2559
LOSS	Loss - only in Pre
UNCH	Unchanged - if used, Post = Pre
MODD	Modified-Direct - Pre = Post
MODI	Modified-Indirect - Pre = Post
COMM	Compensation-Modified - Pre = Post
COMC	Compensation-Created - only in Post

Study Site
Not Applying Indirect Effect

Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17			
	Coldwater piscivores	0.17			
	Coolwater non-piscivores	0.17			
	Coolwater piscivores	0.17			
	Warmwater non-piscivores	0.17			
	Warmwater piscivores	0.17			
Spawning	Coldwater non-piscivores	0.17			
	Coldwater piscivores	0.17			
	Coolwater non-piscivores	0.17			
	Coolwater piscivores	0.17			
	Warmwater non-piscivores	0.17			
	Warmwater piscivores	0.17			
YOY	Coldwater non-piscivores	0.17			
	Coldwater piscivores	0.17			
	Coolwater non-piscivores	0.17			
	Coolwater piscivores	0.17			
	Warmwater non-piscivores	0.17			
	Warmwater piscivores	0.17			
Weighted Sum					
Adult		0.33			
Spawning		0.33			
YOY		0.33			
Over All Sum					

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS					
MODD					
MODI					
COMM					
COMC					
TOTAL					

Case 1. Shoreline Protection, Scarborough, Lake Ontario

Date Authorized: 1994/12/15
Project Location: Lake Ontario, Burlington District.

Project Activities
Proposal: Shoreline protection with nearshore habitat rehabilitation features to control erosion of bluffs threatening loss of property and houses.
Size of Work Area (Area LOSS + MODD): 38,433 m^2.
Description of Work: (1) Stepped armourstone revetment backfilled with soil. Area lost 34,878 m^2.
(2) Armourstone revetment below high water mark 75.05 m IGLD. Area modified 3,555 m^2.
Material Used: 1 – 3 tonne armourstone for stepped revetments.

Pre Condition
Narrow beach of coarse sand and gravel at the base of quickly eroding 55 m high bluffs. Water depth is 0 - 3 m and supports coldwater fish.

Indirect Effects
Submerged breakwater elevated between 74.0 and 75.0 m acts to shelter area from wave exposure, affecting area (4).
(7) Area protected on leeward side of breakwater approximately 2 m deep with substrate 5 –15 cm diameter. Area modified indirectly 330 m^2.

Compensation
Proposal: Enhance fish habitat, particularly coldwater fisheries, with protected beaches, submerged breakwaters and substrate patches.
Size of Compensation: 10,274 m^2.
Description of Work: (3) Boulder toe along entire armoured shoreline, elevated at approximately 74.6 m and 5 m wide. Area modified 4,067 m^2.
(4) Protected cobble beaches with a 7:1 slope. Area modified 2,425 m^2.
(5) Protecting the beach is a submerged reef/breakwater with groynes extending from the lakeward side (total of 5 groynes between the two breakwaters). Breakwater is sloped towards the lake from 75.0 to 74.0 m elevations, and the groynes are elevated to 74.0 m. Area modified 3,282 m^2.
(6) Between the groynes on the lakeside of the breakwater, are substrate patches of rubble/cobble, 10 x 10 m in size (for a total of 5 patches). Area modified 500 m^2.
Material Used: Entire boulder toe composed of rip rap 60 cm in diameter. Stone 5-15 cm in diameter used for the gravel beach, and submerged breakwaters are made up of a rubble/shot rock core covered with larger boulders, 500 kg – 4 tonne. Interstitial spaces on the shore side of the breakwater are filled with small cobble and gravel, 60 cm diameter. Cobble/gravel material used for substrate patches in area of the submerged reefs.

Case 1 (cont'd)

HAAT Analysis

Assumptions: Areas estimated with scaled drawings and paper weight method.

Results:

Not Applying Indirect Effect

- Overall project results in a loss of fish habitat.
- Largest loss of coldwater piscivore YOY habitat, and no gain for any fish habitat.
- YOY fish habitat impacted more than adult and spawning habitat.

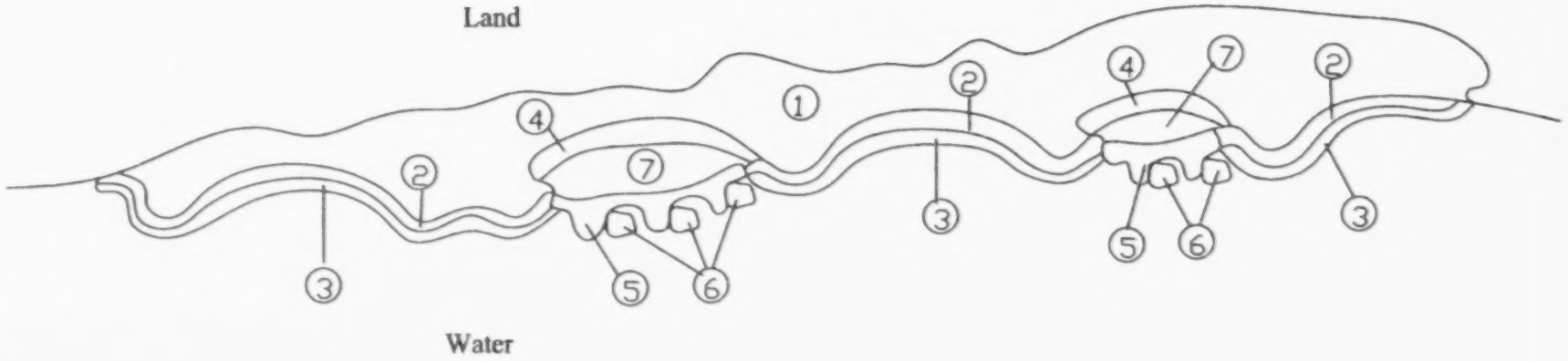
Applying Indirect Effect

- Overall project results in a loss of fish habitat, less than when indirect effect not applied.
- Largest loss of coldwater piscivore YOY habitat, and no gain for any fish habitat.
- YOY fish habitat impacted more than adult and spawning habitat.

Case 1. Shoreline Protection, Scarborough, Lake Ontario

Pre-Construction Phase

Post-Construction Phase



Case 1 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	34878	LOSS	1	0-2.2	55% gravel 45% sand	no cover	1							
2	3555	MODD	0.64	0-2.2	55% gravel 45% sand	no cover	2	3555	MODD	0.64	0-1.6	100% boulder	no cover	armourstone revetment
3	4067	COMM	0.64	0-2.2	55% gravel 45% sand	no cover	3	4067	COMM	0.64	0.7-1.55	100% boulder	no cover	boulder toe
4	2425	COMM	0.64	1-2.5	55% gravel 45% sand	no cover	4	2425	COMM	1	0-2.05	100% rubble	no cover	cobble beach
5	3282	COMM	0.64	1-2.8	55% gravel 45% sand	no cover	5	3282	COMM	0.64	0-1.05	20% rubble 25% cobble 55% boulder	no cover	submerged breakwater/groynes
6	500	COMM	0.64	1-2.8	55% gravel 45% sand	no cover	6	500	COMM	0.64	2.0	60% cobble 40% gravel	no cover	cobble/gravel patches
7	330	MODI	0.64	1-2.8	55% gravel 45% sand	no cover	7	330	MODI	1	1.5-2.5	30% gravel 70 % rubble	no cover	sheltering effect of reef

Case 1 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	34878	LOSS	1	60	35	5	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100
2	3555	MODD	0.64	10	70	20	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100
3	4067	COMM	0.64	10	70	20	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100
4	2425	COMM	0.64	0	80	20	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100
5	3282	COMM	0.64	0	70	30	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100
6	500	COMM	0.64	0	70	30	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100
7	330	MODI	0.64	0	70	30	0	0	100	0	0	0	0	55	45	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	3555	MODD	0.64	60	40	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	4067	COMM	0.64	15	85	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
4	2425	COMM	1	45	45	10	0	0	100	0	0	0	100	0	0	0	0	0	100	0	0	100	100
5	3282	COMM	0.64	90	10	0	0	0	100	0	40	20	20	20	0	0	0	0	100	0	0	100	100
6	500	COMM	0.64	0	100	0	0	0	100	0	40	20	20	20	0	0	0	0	100	0	0	100	100
7	330	MODI	1	50	50	0	0	0	100	0	0	0	70	30	0	0	0	0	100	0	0	100	100

Case 1 (cont'd)
Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	9343.7	974.2	-8369.5
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	38927.1	4391.8	-34535.3
	Coolwater piscivores	0.17	1977.2	438	-1539.2
	Warmwater non-piscivores	0.17	33875.1	3838	-30037.1
	Warmwater piscivores	0.17	29903.7	3201.3	-26702.4
Spawning	Coldwater non-piscivores	0.17	32958.4	5414.2	-27544.2
	Coldwater piscivores	0.17	32414.6	7788.2	-24626.4
	Coolwater non-piscivores	0.17	24078.6	3150.9	-20927.7
	Coolwater piscivores	0.17	3011.6	230.1	-2781.5
	Warmwater non-piscivores	0.17	24896.4	2805.1	-22091.3
	Warmwater piscivores	0.17	9205.2	1363.5	-7841.7
YOY	Coldwater non-piscivores	0.17	36619.5	2961	-33658.5
	Coldwater piscivores	0.17	43608.2	2603.5	-41004.7
	Coolwater non-piscivores	0.17	33168.8	1076.8	-32092
	Coolwater piscivores	0.17	3333.6	19.1	-3314.5
	Warmwater non-piscivores	0.17	9040.8	465.1	-8575.7
	Warmwater piscivores	0.17	11208.5	1939.6	-9268.9
Weighted Sum					
Adult		0.33	19004.5	2140.5	-16864
Spawning		0.33	21094.1	3458.7	-17635.4
YOY		0.33	22829.9	1510.9	-21319
OverAll Sum			20976.2	2370	-18606.2

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	34878	0	15631.8	0	-15631.8
MODD	3555	3555	1370	368	-1002
MODI	330	330	119.8	109.2	-10.6
COMM	10274	10274	3854.6	1892.8	-1961.8
COMC					
TOTAL			20976.2	2370	-18606.2

Case 1 (cont'd)
Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	8295.6	757.1	-7538.5
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	35254.8	3304.4	-31950.4
	Coolwater piscivres	0.17	1771.6	320.3	-1451.3
	Warmwater non-piscivores	0.17	30589.8	2983	-27606.8
	Warmwater piscivores	0.17	26795.3	2473.3	-24322
Spawning	Coldwater non-piscivores	0.17	30419.6	3931.9	-26487.7
	Coldwater piscivores	0.17	29045.2	5675.1	-23370.1
	Coolwater non-piscivores	0.17	23037.4	2411	-20626.4
	Coolwater piscivores	0.17	2807.4	174.7	-2632.7
	Warmwater non-piscivores	0.17	23837.9	2097.7	-21740.2
	Warmwater piscivores	0.17	8360.3	1094.5	-7265.8
YOY	Coldwater non-piscivores	0.17	32469.2	2127.2	-30342
	Coldwater piscivores	0.17	38990.7	2098.9	-36891.8
	Coolwater non-piscivores	0.17	29930.5	844.4	-29086.1
	Coolwater piscivores	0.17	3020.1	13	-3007.1
	Warmwater non-piscivores	0.17	8212.9	389.7	-7823.2
	Warmwater piscivores	0.17	10101	1426.7	-8674.3
Weighted Sum					
Adult		0.33	17117.9	1639.7	-15478.2
Spawning		0.33	19584.6	2564.1	-17020.5
YOY		0.33	20454.1	1150	-19304.1
Over All Sum			19052.2	1784.6	-17267.6

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	34878	0	15631.8	0	-15631.8
MODD	2275.2	2275.2	876.8	235.5	-641.3
MODI	211.2	330	76.7	109.2	32.5
COMM	6575.4	7448.4	2466.9	1439.9	-1027
COMC	-	-	-	-	
TOTAL			19052.2	1784.6	-17267.6

Case 2. Infilling, Retaining Wall, Long Point, Lake Erie

Date Authorized: 1994/04/26
Project Location: Lake Erie, Sarnia District.

Project Activity

Proposal: Increase square footage of land to allow installation of septic system.
Size of Work Area (Area LOSS + MODD): 40.5 m^2.
Description of Work: (1) Backfill behind a 17 m long steel wall. Area lost 40.5 m^2.
Material Used: Steel retaining wall.

Pre Condition

Silty substrate in area of infilling, water depth 0 - 1.5 m.
Compensation area, formerly dry land.

Indirect Effects

None.

Compensation

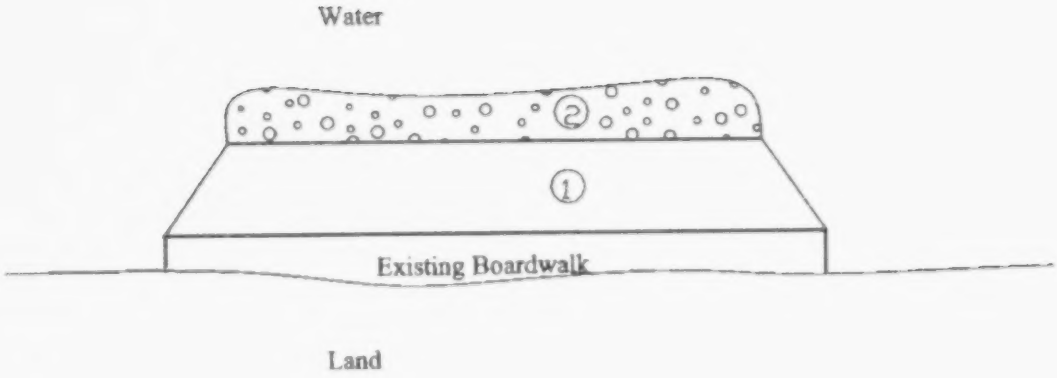
Proposal: Habitat created in neighbouring marsh with an average depth of 0.2 m, sloping into boat channel (1.5 m deep). No substrate laid down. Toe added to base of steel wall.
Size of Compensation Area: 82.1 m^2.
Description of Work: (2) Pea gravel toe to base of steel wall. Area modified 17 m^2.
(3) Area created in neighbouring marsh. Area created 65.1 m^2.
Material Used: Pea gravel toe, size not specified.

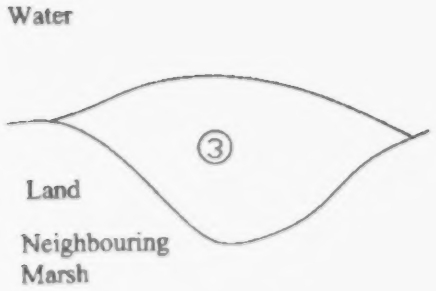
HAAT Analysis

Assumptions: Width of pea stone gravel toe planned to be 1 m for the entire length of the steel wall (17 m). Size of pea stone assumed to be 50% cobble, 25% rubble and 25% sand.
No specification of substrate being laid down, so assumed none placed and similar substrate exposed as in pre condition of steel wall.
Silty substrate assumed to be made up of 80% silt, 10% sand and 10% clay.
Results:

- Overall project resulted in a gain in fish habitat.
- No type of habitat suffered a loss, and the largest gain for adult coolwater non-piscivore habitat.
- Collectively spawning habitat experienced a greater gain over YOY and adult habitat.

Pre- and Post-Construction phase photographs not available





Case 2 (cont'd)

PRE-Development Scenario							**POST**-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	40.5	LOSS		0-1.5	10% sand 80% silt 10% clay	no cover	1							steel retaining wall
2	17	COMM		0-1.5	10% sand 80% silt 10% clay	no cover	2	17	COMM		0-1.5	50% cobble 25% rubble 25% gravel	no cover	toe at base of wall
3							3	65.1	COMC		0.2	10% sand 80% silt 10% clay	no cover	created fish habitat in marsh

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	40.5	LOSS		80	20	0	0	0	100	0	0	0	0	0	10	80	10	0	100	0	0	100	100
2	17	COMM		80	20	0	0	0	100	0	0	0	0	0	10	80	10	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	17	COMM		80	20	0	0	0	100	0	0	50	25	25	0	0	0	0	100	0	0	100	100
3	65.1	COMC		85	15	0	0	0	100	0	0	0	0	0	10	80	10	0	100	0	0	100	

Case 2 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	7.4	9.6	2.2
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	18.5	30.7	12.2
	Coolwater piscivores	0.17	2	3	1
	Warmwater non-piscivores	0.17	14.8	23.6	8.8
	Warmwater piscivores	0.17	31.4	40.9	9.5
Spawning	Coldwater non-piscivores	0.17	7.8	18.3	10.5
	Coldwater piscivores	0.17	10.1	20.5	10.4
	Coolwater non-piscivores	0.17	7.8	17.8	10
	Coolwater piscivores	0.17	7.3	9	1.7
	Warmwater non-piscivores	0.17	13	22.1	9.1
	Warmwater piscivores	0.17	1.6	4.2	2.6
YOY	Coldwater non-piscivores	0.17	19.6	26.4	6.8
	Coldwater piscivores	0.17	13.8	21.6	7.8
	Coolwater non-piscivores	0.17	40.6	49.4	8.8
	Coolwater piscivores	0.17	11	12.5	1.5
	Warmwater non-piscivores	0.17	14.4	17.4	3
	Warmwater piscivores	0.17	15.3	19.7	4.4
Weighted Sum					
Adult		0.33	12.3	18	5.7
Spawning		0.33	8	15.3	7.3
YOY		0.33	19.1	24.5	5.4
Over All Sum.			13.1	19.3	6.2

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	40.5	0	9.2	0	-9.2
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	17	17	3.9	4.3	0.4
COMC	0	65.1	0	14.9	14.9
TOTAL			13.1	19.2	6.1

Case 3. Dredging, Infilling And Blasting, Town of Bruce Mines, Lake Huron

Date Authorized: 1995/02/22
Project Location: Lake Huron, Sudbury District.

Project Activity
Proposal: Dredging boat channel, and extend existing loading dock.
Size of Work Area (Area LOSS + MODD): 23,000 m^2.
Description of Work: (1) Extending existing dock, consisting on 4 steel pile dolphins, a loading platform, and a rock fill area. Area lost 8 000 m^2.
(2) Ship channel, 50 m wide by 1219 m long. Dredged to a depth of 7.9 m below chart datum. Area modified 15,000 m^2.
Material Used: Loading dock constructed with steel pile dolphins and rock fill extracted from dredged boat channel.

Pre Condition
Ship channel originally predominately clayey overburden soils (silt and clay) overlaying bedrock.

Indirect Effects
None.

Compensation
Proposal: Submerged shoal, areas of rock and rootwad placement.
Size of Compensation Area: 26,425 m^2.
Description of Work: (3) Large angular rock material placed on north facing slope to provide cover. Consists of 75% rock 45 cm, 25% 15 - 45 cm. Area modified 675 m^2.
(4) Rock material along shoreline 45 cm. Offshore 5% < 5 cm, 15% 5-10cm gravel, 60% 10 – 25 cm rubble, and 20% > 25 cm. Area 30 m wide by 465 m long. Area modified 13,950 m^2.
(5) Quarry stone and blast rock 5% < 5 cm, 15% 5 – 10 cm gravel, 60% 10 - 25 cm rubble, 20% > 25 cm, to a mean depth of 30 cm. Area modified 2,300 m^2.
(6) Footprint of shoal, 30 m wide made up of 60% 10 – 25 cm rubble, 20% > 25 cm. Area modified 7,100 m^2.
(7) Side slopes of shoal, 1.5:1 – 3:1 slope, with rock 25% 5 – 25 cm, 75% 25 – 45 cm. Area modified 2,200 m^2.
(8) Submerged shoal, 25% 5 - 25 cm, 75% 25 – 45 cm. Area modified 200 m^2.
Material Used: Blast and quarry rock of various size, and local trees used for cover.

Case 3 (cont'd)

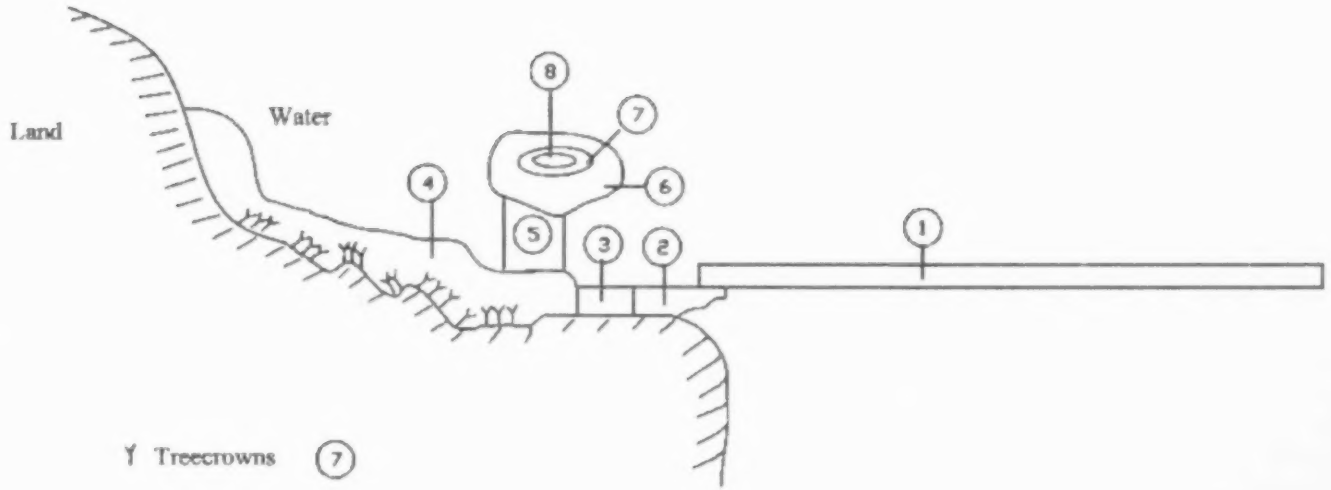
HAAT Analysis

Assumptions: Cover provided by tree crowns.

Results:

- Overall project resulted in the net loss of fish habitat.
- Largest gain in coldwater non-piscivore spawning habitat and the largest loss in coolwater non-piscivore YOY habitat.
- Collectively spawning habitat experienced a gain in habitat, while YOY and adult habitat suffered a loss.

Pre- and Post-Construction phase photographs not available



Case 3 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	8000	LOSS		0-4	65% silt 35% clay	no cover								dock installed
2	15000	MODD		3-7.7	65% silt 35% clay	no cover	2	15000	MODD		7.9	75% bedrock 20% silt 5% clay	no cover	boat channel dredged
3	675	COMM		3	65% silt 35% clay	no cover	3	675	COMM		3	75% boulder 20% cobble 5% rubble	no cover	rock compensation area
4	13950	COMM		0.15-1.5	65% silt 35% clay	no cover	4	13950	COMM		0.15-1.5	20% boulder 45% cobble 27% rubble 8% gravel	15% submergent 5% emergent 80% no cover	rock and root wad compensation area
5	2300	COMM		0-2	65% silt 35% clay	no cover	5	2300	COMM		0-3	20% boulder 45% cobble 27% rubble 8% gravel	no cover	rock rubble compensation area
6	7100	COMM		0-3.3	65% silt 35% clay	no cover	6	7100	COMM		0-3.3	20% boulder 45% cobble 27% rubble 8% gravel	no cover	footprint of shoal
7	2200	COMM		0-3	65% silt 35% clay	no cover	7	2200	COMM		0-3	75% boulder 10% cobble 10% rubble 5% gravel	no cover	side sloped of shoal
8	200	COMM		0-1	75% boulder 10% cobble 10% rubble 5% gravel	no cover	8	200	COMM		0-1	75% boulder 10% cobble 10% rubble 5% gravel	no cover	submerged shoal

Case 3 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	8000	LOSS		35	50	15	0	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
2	15000	MODD		0	0	20	80	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
3	675	COMM		0	0	100	0	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
4	13950	COMM		70	25	5	0	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
5	2300	COMM		50	50	0	0	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
6	7100	COMM		10	55	35	0	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
7	2200	COMM		15	60	25	0	0	100	0	0	0	0	0	0	65	35	0	100	0	0	100	100
8	200	COMM		100	0	0	0	0	100	0	75	10	10	5	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	15000	MODD		0	0	0	100	0	100	75	0	0	0	0	0	20	5	0	100	0	0	100	100
3	675	COMM		0	0	100	0	0	100	0	75	20	5	0	0	0	0	0	100	0	0	100	100
4	13950	COMM		70	25	5	0	0	100	0	20	45	27	8	0	0	0	0	100	0	0	100	100
5	2300	COMM		100	0	0	0	0	100	0	20	45	27	8	0	0	0	0	100	15	5	80	100
6	7100	COMM		10	55	35	0	0	100	0	20	45	27	8	0	0	0	0	100	0	0	100	100
7	2200	COMM		15	60	25	0	0	100	0	75	10	10	5	0	0	0	0	100	0	0	100	100
8	200	COMM		100	0	0	0	0	100	0	75	10	10	5	0	0	0	0	100	0	0	100	100

Case 3 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5593.6	2502.8	-3090.8
	Coldwater piscivores	0.17	1364.2	751.7	-612.5
	Coolwater non-piscivores	0.17	8952.3	10289.3	1337
	Coolwater piscivores	0.17	6611.8	1892.9	-4718.9
	Warmwater non-piscivores	0.17	7092	7434.7	342.7
	Warmwater piscivores	0.17	19280.8	7984.4	-11296.4
Spawning	Coldwater non-piscivores	0.17	4021.3	14571.9	10550.6
	Coldwater piscivores	0.17	5260.8	12640	7379.2
	Coolwater non-piscivores	0.17	2448	6791.4	4343.4
	Coolwater piscivores	0.17	3508.1	1491.2	-2016.9
	Warmwater non-piscivores	0.17	4015.2	5011	995.8
	Warmwater piscivores	0.17	647.8	3005.3	2357.5
YOY	Coldwater non-piscivores	0.17	6351.5	4330.9	-2020.6
	Coldwater piscivores	0.17	6723.9	6633.4	-90.5
	Coolwater non-piscivores	0.17	19795.9	2934.9	-16861
	Coolwater piscivores	0.17	5889.8	276.1	-5613.7
	Warmwater non-piscivores	0.17	5416.9	960.7	-4456.2
	Warmwater piscivores	0.17	6691.5	4604.4	-2087.1
Weighted Sum					
Adult		0.33	8149.1	5142.6	-3006.5
Spawning		0.33	3316.9	7251.8	3934.9
YOY		0.33	8478.2	3290.1	-5188.1
Over All Sum			6648.1	5228.2	-1419.9

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	8000	0	1243.1	0	-1243.1
MODD	15000	15000	1302.3	689.9	-612.4
MODI	-	-	-	-	-
COMM	26425	26425	4102.7	4538.3	435.6
COMC	-	-	-	-	-
TOTAL			6648.1	5228.2	-1419.9

Case 4. Shoreline Stabilization, Grimsby, Lake Ontario

Date Authorized: 1995/08/28
Project Location: Lake Ontario, Burlington District.

Project Activity
Proposal: Erosion control and shoreline stabilization with a small groyne, two 90 m long armourstone walls, and extending an existing armourstone revetment 70 m with 2:1 slopes.
Size of Work Area (Area LOSS + MODD): 2,879.5 m^2.
Description of Work: (1) West armourstone wall above water line 74.9 m IGLD (June 1995). Area lost 192.36 m^2.
(2) West armourstone wall below water line. Area modified 208 m^2.
(3) 35 m long armourstone groyne above water line. Area lost 397 m^2.
(5) Cobble beach above the high water mark. Area lost 971.7 m^2.
(7) Armourstone revetment above the water line. Area lost 478.7 m^2.
(8) Armourstone revetment below the water line. Area modified 300.2 m^2.
(9) East armourstone wall above water line. Area lost 192.7 m^2.
(10) East armourstone wall below water line. Area modified 138.9 m^2.
Material Used: Armourstone 0.5 to 1.0 tonne for revetment and 4 - 6 tonne for groyne and seawalls. River washed cobble stones 5 - 15 cm diameter for cobble beach.

Pre Condition
Bank nearly vertical with 7 m high bluffs of red shale bedrock. Nearshore 0 – 2 m deep, substrate shale bedrock, with scattered boulder and cobble/gravel patches.
Existing armourstone revetment 3:1 to 2:1 slope.

Indirect Effects
None.

Compensation
Proposal: Armourstone groyne and cobble beach.
Size of Compensation Area: 316.3 m^2.
Description of Work: (4) Armourstone groyne below the high water mark side slopes 1.5:1. Area modified 226.5 m^2.
(6) Cobble beach below the high water mark. Area modified 89.8 m^2.
Material Used: Armourstone 4 - 6 tonnes for groyne and river washed stones 5 - 15 cm diameter for cobble beach.

Case 4 (cont'd)

HAAT Analysis

Assumptions: All areas of the project measured with scaled drawings and paper weight method. Composition of pre-condition substrate estimated from description given.

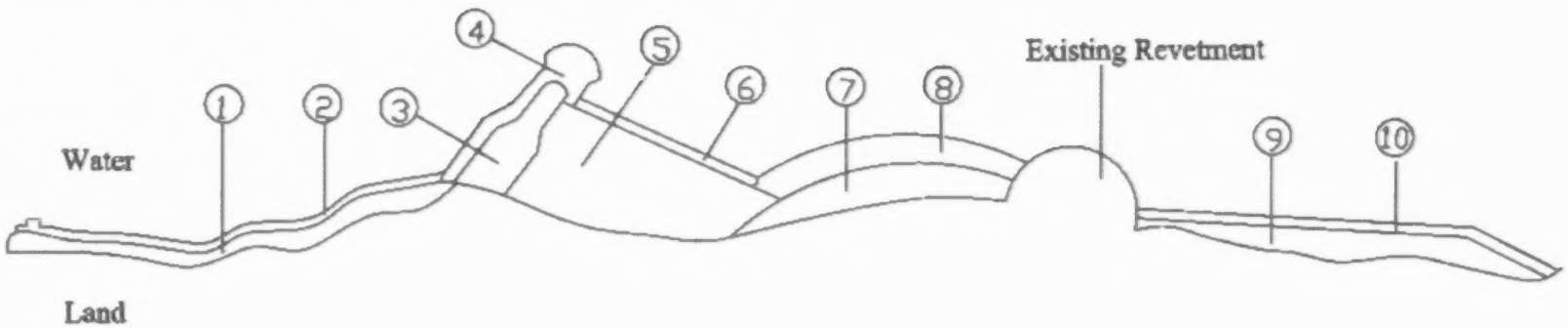
Results:

- Overall project resulted in a loss of fish habitat.
- Largest loss in warmwater piscivore spawning habitat, and largest gain in coldwater non-piscivore spawning habitat.
- Collectively adult fish habitat experienced a slight gain while spawning and YOY habitat suffered losses.

Case 4. Shoreline Stabilization, Grimsby, Lake Ontario

Pre-Construction Phase

Post-Construction Phase



Case 4 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	192.4	LOSS		0-1	75% bedrock 10% boulder 15% cobble	no cover	1							armourstone wall
2	208	MODD		0-1	75% bedrock 10% boulder 15% cobble	no cover	2	208	MODD		0-1	100% boulder	no cover	armourstone wall
3	397	LOSS		0-2	75% bedrock 10% boulder 15% cobble	no cover	3							armourstone groyne
4	226.5	COMM		0-2	75% bedrock 10% boulder 15% cobble	no cover	4	226.5	COMM		0-1	100% boulder	no cover	armourstone groyne
5	971.7	LOSS		0-2	75% bedrock 10% boulder 15% cobble	no cover	5							cobble beach
6	89.85	COMM		0-2	75% bedrock 10% boulder 15% cobble	no cover	6	89.85	COMM		0-1.2	65% rubble 35% gravel	no cover	cobble beach
7	478.7	LOSS		0-1.5	75% bedrock 10% boulder 15% cobble	no cover	7							armourstone revetment
8	300.2	MODD		0-1.5	75% bedrock 10% boulder 15% cobble	no cover	8	300.2	MODD		0-0.5	100% boulder	no cover	armourstone revetment
9	192.7	LOSS		0-1.3	75% bedrock 10% boulder 15% cobble	no cover	9							armourstone wall
10	138.9	MODD		0-1.3	75% bedrock 10% boulder 15% cobble	no cover	10	138.9	MODD		0-0.2	100% boulder	no cover	armourstone wall

Case 4 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	192	LOSS		100	0	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
2	208	MODD		100	0	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
3	397	LOSS		25	75	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
4	227	COMM		25	75	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
5	972	LOSS		40	60	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
6	89.9	COMM		0	100	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
7	479	LOSS		70	30	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
8	300	MODD		20	80	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
9	193	LOSS		90	10	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100
10	139	MODD		90	10	0	0	0	100	75	10	15	0	0	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	208	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
4	227	COMM		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
6	89.9	COMM		75	25	0	0	0	100	0	0	0	65	35	0	0	0	0	100	0	0	100	100
8	300	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
10	139	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100

Case 4 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	117.7	45.8	-71.9
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	190	226.7	36.7
	Coolwater piscivores	0.17	21.5	27.1	5.6
	Warmwater non-piscivores	0.17	189.7	167.7	-22
	Warmwater piscivores	0.17	102	154.5	52.5
Spawning	Coldwater non-piscivores	0.17	260.6	441.6	181
	Coldwater piscivores	0.17	824.1	477.3	-346.8
	Coolwater non-piscivores	0.17	105	137.6	32.6
	Coolwater piscivores	0.17	35.4	12.3	-23.1
	Warmwater non-piscivores	0.17	145.4	126.4	-19
	Warmwater piscivores	0.17	447.6	55.5	-392.1
YOY	Coldwater non-piscivores	0.17	147.5	181.1	33.6
	Coldwater piscivores	0.17	39.8	51	11.2
	Coolwater non-piscivores	0.17	129.2	30.7	-98.5
	Coolwater piscivores	0.17	0	0.7	0.7
	Warmwater non-piscivores	0.17	3.3	11	7.7
	Warmwater piscivores	0.17	283.4	119	-164.4
Weighted Sum					
Adult		0.33	103.5	103.6	0.1
Spawning		0.33	303	208.4	-94.6
YOY		0.33	100.5	65.6	-34.9
Over All Sum			169	125.9	-43.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	2232.4	0	118.3	0	-118.3
MODD	647.1	647.1	34.5	69.4	34.9
MODI	-	-	-	-	
COMM	316.4	316.4	16.2	56.5	40.3
COMC	-	-	-	-	-
TOTAL			169	125.9	-43.1

Case 5. Breakwater Construction, Prince Edward County, Lake Ontario

Date Authorized: 1997/04/03
Project Location: Lake Ontario, Prescott District.

Project Activity
Proposal: Construction and a quarry stone beach, and two groynes.
Size of Work Area: 739.9 m^2
Description of Work (Area LOSS + MODD): (1) Portion of solid groyne 30.5 m long by 3.6 m wide above annual high water mark 75.75 IGLD. Area lost 105 m^2.
(2) Side slopes of groyne 2.5:1 and above high water mark. Area lost 97 m^2.
(3) Submerged slopes of groyne 2.5:1 and 2:1 slopes. Area modified 366 m^2.
(5) Smaller groyne 5 m elevated to the high water mark. Area lost 7.7 m^2.
(6) Submerged 2:1 slopes of small groyne. Area modified 11.64 m^2.
(7) Stone beach. Area lost 74 m^2.
(8) Edge of stone beach submerged. Area modified 78.6 m^2.
Material Used: Concrete groyne crib filled with limestone rubble and surrounded by 2 - 3 tonne quarry stone at a 2.5:1 slope. Smaller groyne and stone beach also constructed with 2 - 3 tonne quarry stone.

Pre Condition
Shingle substrate water 0 - 6 m deep. Sometime in the past, concrete blocks had been placed along the beach to prevent further erosion of the shingle material.

Indirect Effects
(9) Area protected from lake exposure on leeward side of groyne, water 0 - 4 m deep and substrate unchanged. Area modified indirectly 308.8 m^2.

Compensation
Proposal: Boat slip excavated inland.
Size of Compensation Area: 487 m^2.
Description of Work: (4) Boat slip 13.7 m wide by 30.5 m long, dredged to 2.7 - 3.5 m deep. Area created 487 m^2.
Material Used: 30 cm layer of rock rubble placed to cover bottom of slip.

Case 5 (cont'd)

HAAT Analysis

Assumptions: Size composition of shingle substrate using photo of pre condition. Size composition of the rock rubble placed in area of boat slip. Area indirectly effected from the addition of proposed groyne, estimated on scaled drawing using paper weight method.

Areas of infill and modification estimated using the paper weight method and a scaled diagram.

Results:

Not Applying Indirect Effects

- Overall project resulted in a net loss of fish habitat.
- Largest loss for coolwater non-piscivore adult fish habitat, and the largest gain in warmwater piscivore YOY habitat.
- Collectively the largest loss was experienced by adult fish habitat, over YOY and spawning habitats.

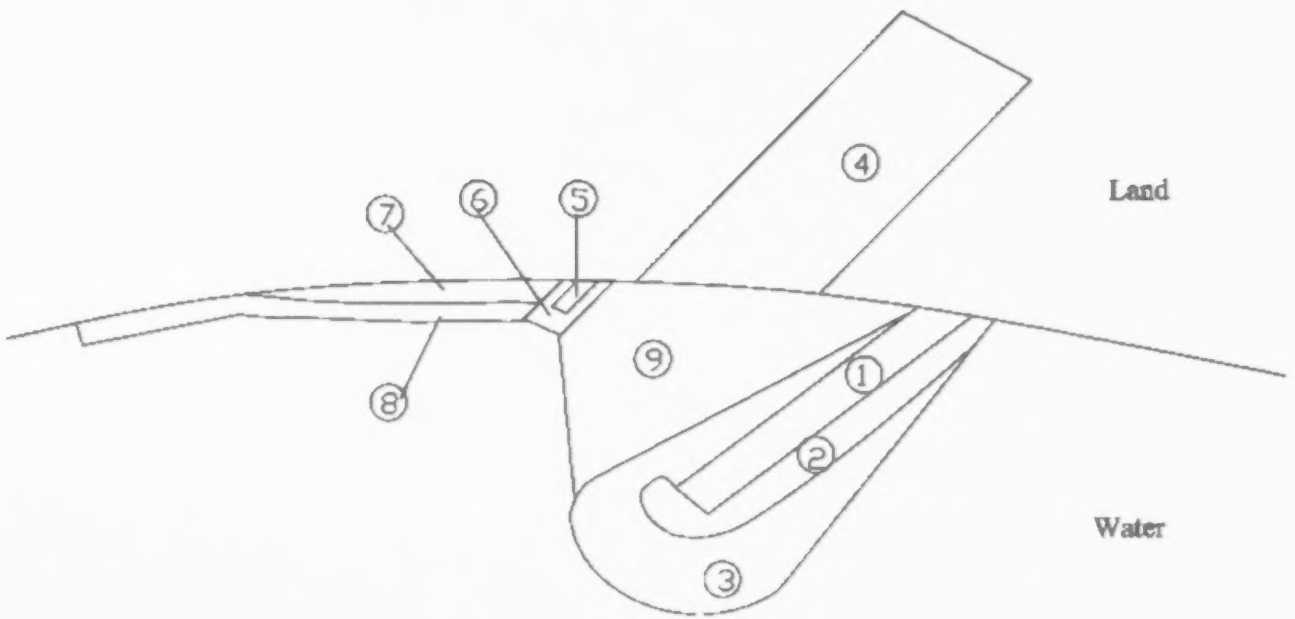
Applying Indirect Effects

- Overall project results in a net loss of fish habitat, less than when indirect effect not applied.
- Largest loss for coolwater non-piscivore spawning fish habitat, largest gain in coldwater piscivore spawning habitat.
- Collectively, project caused the loss of adult fish habitat, while YOY habitat experienced a larger gain over spawning habitat.

Case 5. Breakwater Construction, Prince Edward County, Lake Ontario

Pre-Construction Phase

Post-Construction phase photograph not available



Case 5 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	105	LOSS	1.0	0-4	10% boulder 15% cobble 50% rubble 25% gravel	no cover	1							armourstone groyne
2	97	LOSS	1.0	0-4.5	10% boulder 15% cobble 50% rubble 25% gravel	no cover	2							armourstone groyne slope 2:1
3	366	MODD	0.64	0-5.3	10% boulder 15% cobble 50% rubble 25% gravel	no cover	3	366	MODD	0.64	0-5.3	100% boulder	no cover	armourstone groyne slope 2:1
4							4	487	COMC	1.0	2.7-3.5	40% cobble 45% rubble 15% gravel	no cover	derdged boat channel
5	7.7	LOSS	1.0	0-2	10% boulder 15% cobble 50% rubble 25% gravel	no cover	5							small groyne
6	11.64	MODD	0.64	0-2	10% boulder 15% cobble 50% rubble 25% gravel	no cover	6	11.64	MODD	0.64	0-1	100% boulder	no cover	small groyne
7	74	LOSS	1.0	0-1.5	10% boulder 15% cobble 50% rubble 25% gravel	no cover	7							boulder revetment
8	78.6	MODD	0.64	0-2	10% boulder 15% cobble 50% rubble 25% gravel	no cover	8	78.6	MODD	0.64	0-1	100% boulder	no cover	boulder revetment
9	308.8	MODI	0.64	0-4	10% boulder 15% cobble 50% rubble 255 gravel	no cover	9	308.8	MODI	1.0	0-4	10% boulder 15% cobble 50% rubble 25% gravel	no cover	sheltering effect of groyne

Case 5 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	105	LOSS	1.0	10	15	75	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
2	97	LOSS	1.0	10	10	70	10	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
3	366	MODD	0.64	10	10	60	20	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
5	7.7	LOSS	1.0	50	50	0	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
6	11.6	MODD	0.64	45	45	10	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
7	74	LOSS	1.0	85	15	0	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
8	78.6	MODD	0.64	40	60	0	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100
9	308.8	MODI	0.64	10	30	60	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
3	366	MODD	0.64	10	25	55	10	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
4	487	COMC	1.0	0	0	100	0	0	100	0	0	40	45	15	0	0	0	0	100	0	0	100	100
6	11.64	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
8	78.6	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
9	308.8	MODI	1.0	10	30	60	0	0	100	0	10	15	50	25	0	0	0	0	100	0	0	100	100

Case 5 (cont'd)

Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	155.3	130.2	-25.1
	Coldwater piscivores	0.17	1.9	1.1	-0.8
	Coolwater non-piscivores	0.17	301.1	184.4	-116.7
	Coolwater piscivores	0.17	38.8	40.7	1.9
	Warmwater non-piscivores	0.17	339.7	225.1	-114.6
	Warmwater piscivores	0.17	407.4	338.1	-69.3
Spawning	Coldwater non-piscivores	0.17	430.4	398.8	-31.6
	Coldwater piscivores	0.17	720.4	734.4	14
	Coolwater non-piscivores	0.17	169	68.8	-100.2
	Coolwater piscivores	0.17	17.3	15.6	-1.7
	Warmwater non-piscivores	0.17	148.9	61.4	-87.5
	Warmwater piscivores	0.17	103.5	67.2	-36.3
YOY	Coldwater non-piscivores	0.17	317.3	260.5	-56.8
	Coldwater piscivores	0.17	524.1	482.8	-41.3
	Coolwater non-piscivores	0.17	159.2	76.1	-83.1
	Coolwater piscivores	0.17	5.9	3.4	-2.5
	Warmwater non-piscivores	0.17	59.2	33.5	-25.7
	Warmwater piscivores	0.17	164.4	178.8	14.4
Weighted Sum					
Adult		0.33	207.4	153.3	-54.1
Spawning		0.33	264.9	224.3	-40.6
YOY		0.33	205	172.5	-32.5
Over All Sum			225.8	183.4	-42.4

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	283.7	0	64.5	0	-64.5
MODD	456.2	456.2	95.8	45	-50.8
MODI	308.8	308.8	65.4	65.4	0
COMM	-	-	-	-	-
COMC	0	487	0	73	73
TOTAL			225.7	183.4	-42.3

Case 5 (cont'd)
Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	113.4	115.1	1.7
	Coldwater piscivores	0.17	1.3	0.7	-0.6
	Coolwater non-piscivores	0.17	224.6	168.7	-55.9
	Coolwater piscivores	0.17	28.6	36.3	7.7
	Warmwater non-piscivores	0.17	252.9	211.6	-41.3
	Warmwater piscivores	0.17	300.4	317.2	16.8
Spawning	Coldwater non-piscivores	0.17	321.5	355.2	33.7
	Coldwater piscivores	0.17	532.4	661.7	129.3
	Coolwater non-piscivores	0.17	132	59.6	-72.4
	Coolwater piscivores	0.17	12.8	13.7	0.9
	Warmwater non-piscivores	0.17	116	54.1	-61.9
	Warmwater piscivores	0.17	77.2	60.8	-16.4
YOY	Coldwater non-piscivores	0.17	232.9	235.5	2.6
	Coldwater piscivores	0.17	384.8	446.6	61.8
	Coolwater non-piscivores	0.17	118.2	76.1	-42.1
	Coolwater piscivores	0.17	4.3	3.4	-0.9
	Warmwater non-piscivores	0.17	44	33.5	-10.5
	Warmwater piscivores	0.17	121.5	159.4	37.9
Weighted Sum					
Adult		0.33	153.5	141.6	-11.9
Spawning		0.33	198.6	200.9	2.3
YOY		0.33	151	159.1	8.1
Over All Sum			167.7	167.2	-0.5

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	283.7	0	64.5	0	-64.5
MODD	292	292	61.3	28.8	32.5
MODI	197.6	308.8	41.9	65.4	23.5
COMM	-	-			
COMC	0	487	0	73	73
TOTAL			167.7	167.2	-0.5

Case 6. Infilling - Railway Embankment Stabilization, Tunnel Bay, Lake Superior

Date Authorized: 1997/07/30
Project Location: Lake Superior, Thunder Bay District.

Project Activity
Proposal: Emergency stabilization, infill to stabilize slumping shoreline.
Size of Work Area (Area LOSS + MODD): 1,967 m^2 (1589 m^2 at Mile 100.5 and 378 m^2 at Mile 100.7)
Description of Work: ***Mile 100.7*** (1) Rip rap sloped at 2.5:1 above Lake Superior ice level (180.0 m). Area lost 269 m^2.
(2) Rip rap sloped at 2.5:1 below ice level. Area modified 109 m^2.
Mile 100.5 (3) Rip rap sloped at 3.8:1 above Lake Superior ice level 179.9 m. Area lost 676 m^2.
(4) Rip rap sloped at 1.5:1 below ice level. Area modified 913 m^2.
Material Used: Rip rap, 15 - 75 cm in diameter with at least 50% larger than 40 cm.

Pre Condition
Mile 100.5 Water depth 0 - 7.5 m, substrate 30% silty clay 70% organic silt and clay.
Mile 100.7 Water depth 0 – 2 m, substrate 100% silty clay.

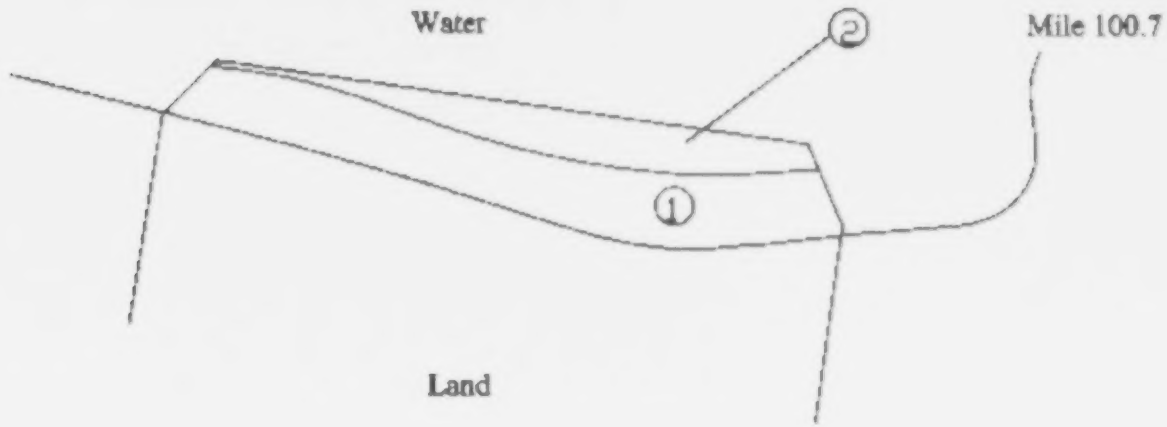
Indirect Effects
None.

Compensation
None.

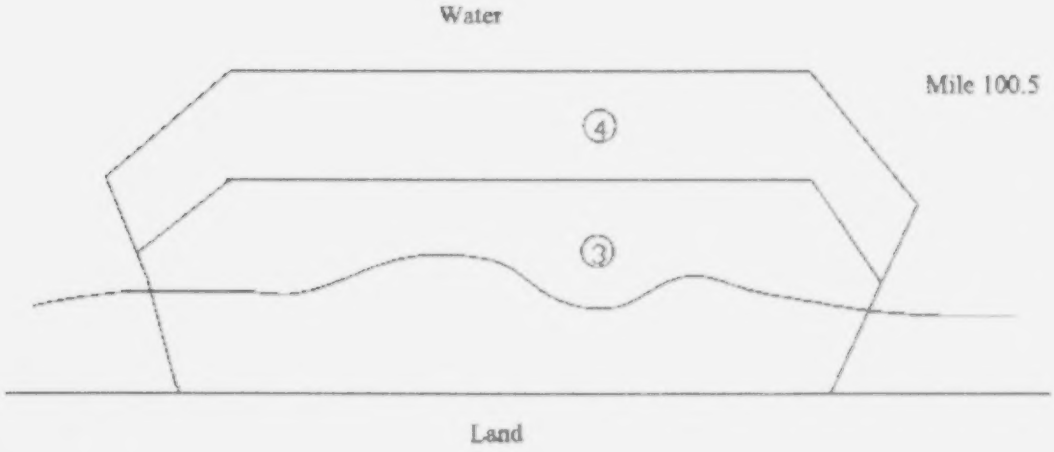
HAAT Analysis
Assumptions: Areas modified and lost estimated using paper weight method and a scaled drawing.
Results:

- Overall project resulted in a loss of fish habitat.
- Largest loss in warmwater piscivore adult habitat, and largest gain in coldwater piscivore spawning habitat.
- Collectively adult fish habitat suffered the greatest loss, over YOY habitat and spawning habitats.

Case 6. Infilling - Railway Embankment Stabilization, Tunnel Bay, Lake Superior



Pre- and Post-Construction phase photographs not available



Case 6 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	269	LOSS		0-0.5	40%silt 60% clay	no cover								
2	109	MODD		0.5-1.5	40%silt 60% clay	no cover	2	109	MODD		0-1	65%boulder 30%cobble 5% rubble	no cover	rip rap revetment
3	676	LOSS		0-4	47%silt 53% clay	no cover								
4	913	MODD		4-12	30%sand 45%silt 25%clay	no cover	4	913	MODD		0-12	65%boulder 30%cobble 5% rubble	no cover	rip rap revetment

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	269	LOSS		100	0	0	0	0	100	0	0	0	0	0	0	40	60	0	100	0	0	100	100
2	109	MODD		75	25	0	0	0	100	0	0	0	0	0	0	40	60	0	100	0	0	100	100
3	676	LOSS		60	20	20	0	0	100	0	0	0	0	0	0	47	53	0	100	0	0	100	100
4	913	MODD		0	0	25	65	10	100	0	0	0	0	0	30	45	25	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	109	MODD		100	0	0	0	0	100	0	65	30	5	0	0	0	0	0	100	0	0	100	100
4	913	MODD		5	15	20	50	10	100	0	65	30	5	0	0	0	0	0	100	0	0	100	100

Case 6 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	195.3	38	-157.3
	Coldwater piscivores	0.17	54.9	17.7	-37.2
	Coolwater non-piscivores	0.17	283.9	77.2	-206.7
	Coolwater piscivores	0.17	292.8	48.2	-244.6
	Warmwater non-piscivores	0.17	259.6	102	-157.6
	Warmwater piscivores	0.17	940.1	254.2	-685.9
Spawning	Coldwater non-piscivores	0.17	377.1	359.9	-17.2
	Coldwater piscivores	0.17	135	199.3	64.3
	Coolwater non-piscivores	0.17	99.6	55	-44.6
	Coolwater piscivores	0.17	73.6	42.4	-31.2
	Warmwater non-piscivores	0.17	54.4	46.7	-7.7
	Warmwater piscivores	0.17	58.6	86.1	27.5
YOY	Coldwater non-piscivores	0.17	608.6	410.9	-197.7
	Coldwater piscivores	0.17	275.6	253	-22.6
	Coolwater non-piscivores	0.17	483.3	3	-480.3
	Coolwater piscivores	0.17	239.1	0	-239.1
	Warmwater non-piscivores	0.17	92.7	6.1	-86.6
	Warmwater piscivores	0.17	288.1	299.7	11.6
Weighted Sum					
Adult		0.33	337.7	89.5	-248.2
Spawning		0.33	133	131.6	-1.4
YOY		0.33	331.2	162.1	-169.1
Over All Sum			267.3	127.7	-139.6

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	945	0	112.8	0	-112.8
MODD	1022	1022	154.5	127.7	-26.8
MODI	-	-	-	-	
COMM	-	-	-	-	
COMC	-	-	-	-	
TOTAL			267.3	127.7	-139.6

Case 7. Shoreline Stabilization (Infill), Hamilton Harbour, Lake Ontario

Date Authorized: 1997/10/02
Project Location: Lake Ontario, Burlington District.

Project Activity

Proposal: Replace old bulging steel retaining wall with a cement revetment.
Size of Work Area: 390 m^2.
Description of Work (Area LOSS + MODD): (1) Rock revetment above high water mark 74.2 m IGLD. Area lost 284.7 m^2.
(2) Rock revetment below high water mark. Area modified 105.3 m^2.
Material Used: Cement revetment covered with 10 - 15 cm substrate.

Pre Condition

Existing marina, water 0 – 1 m deep, and substrate not specified.

Indirect Effects

None.

Compensation

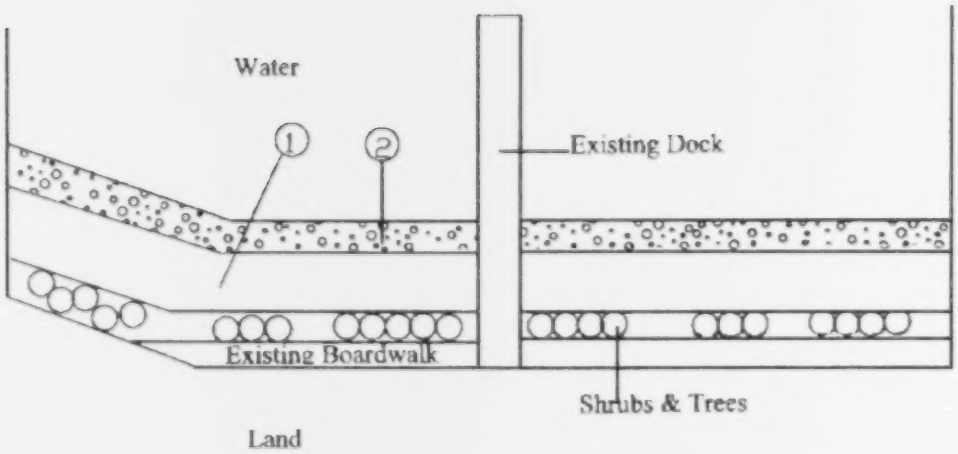
None.

HAAT Analysis

Assumptions: Existing substrate in marina assumed to be 25% cobble, 25% rubble, 25% gravel, 25% silt.
Results:

- Overall project resulted in a loss of fish habitat.
- No habitat types experienced a gain, and the largest loss was in coolwater non-piscivore YOY habitat.
- Collectively spawning habitat suffered a greater loss over adult and YOY habitat.

Pre- and Post-Construction phase photographs not available



Case 7 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	284.7	LOSS		0-1	25% cobble, 25% rubble, 25% gravel, 25% silt	no cover	1							cement revetment
2	105.3	MODD		0-1	25% cobble, 25% rubble, 25% gravel, 25% silt	no cover	2	105.3	MODD		0-1	100% rubble	no cover	cement revetment

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate								*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	285	LOSS		100	0	0	0	0	100	0	0	25	25	25	0	25	0	0	100	0	0	100	100
2	105	MODD		100	0	0	0	0	100	0	0	25	25	25	0	25	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate								*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	105	MODD		100	0	0	0	0	100	0	0	0	100	0	0	0	0	0	100	0	0	100	100

Case 7 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	48.3	14.5	-33.8
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	188.6	54.7	-133.9
	Coolwater piscivores	0.17	13.1	4.2	-8.9
	Warmwater non-piscivores	0.17	184.7	58.1	-126.6
	Warmwater piscivores	0.17	169	44.5	-124.5
Spawning	Coldwater non-piscivores	0.17	205.2	62.4	-142.8
	Coldwater piscivores	0.17	227.5	72.1	-155.4
	Coolwater non-piscivores	0.17	204.9	76.7	-128.2
	Coolwater piscivores	0.17	21.6	3.1	-18.5
	Warmwater non-piscivores	0.17	195.7	55.1	-140.6
	Warmwater piscivores	0.17	52.1	25.4	-26.7
YOY	Coldwater non-piscivores	0.17	118	23.6	-94.4
	Coldwater piscivores	0.17	136.3	37.1	-99.2
	Coolwater non-piscivores	0.17	179.6	15.4	-164.2
	Coolwater piscivores	0.17	23.8	0	-23.8
	Warmwater non-piscivores	0.17	48.5	10	-38.5
	Warmwater piscivores	0.17	72	19.8	-52.2
Weighted Sum					
Adult		0.33	100.6	29.3	-71.3
Spawning		0.33	151.2	49.2	-102
YOY		0.33	96.4	17.6	-78.8
Over All Sum			116.1	32	-84.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	284.7	0	84.7	0	-84.7
MODD	105.3	105.3	31.3	32	0.7
MODI	-			-	-
COMM	-	-	-	-	-
COMC	-				-
TOTAL			116	32	-84

Case 8. Shoreline Stabilization, Burlington, Lake Ontario

Date Authorized: 1998/08/10
Project Location: Lake Ontario, Burlington District.

Project Activity

Proposal: Protect 60 m of lakeshore from erosion using armourstone revetments and groynes.
Size of Work Area (Area LOSS + MODD): 260.5 m^2.
Description of Work: (1) Stepped armourstone revetment 2 rows high 23 m long above the average summer water level 0.9 m above IGLD 1985. Area lost 34.5 m^2.
(2) West groyne 8 m long above average summer water level. Area lost 32 m^2.
(3) West groyne below average summer water level. Area modified 10 m^2.
(4) East groyne 8 m long above average summer water level. Area lost 20 m^2.
(5) East groyne below average summer water level. Area modified 10 m^2.
(6) Cobble beach above average summer water level. Area lost 96 m^2.
(8) Armourstones along toe of existing retaining wall. Area lost 58 m^2.

Pre Condition

Shale substrate with isolated pockets of shingle/cobble material along shoreline. Exposed shoreline on northwest shoreline of Lake Ontario.

Indirect Effects

None.

Compensation

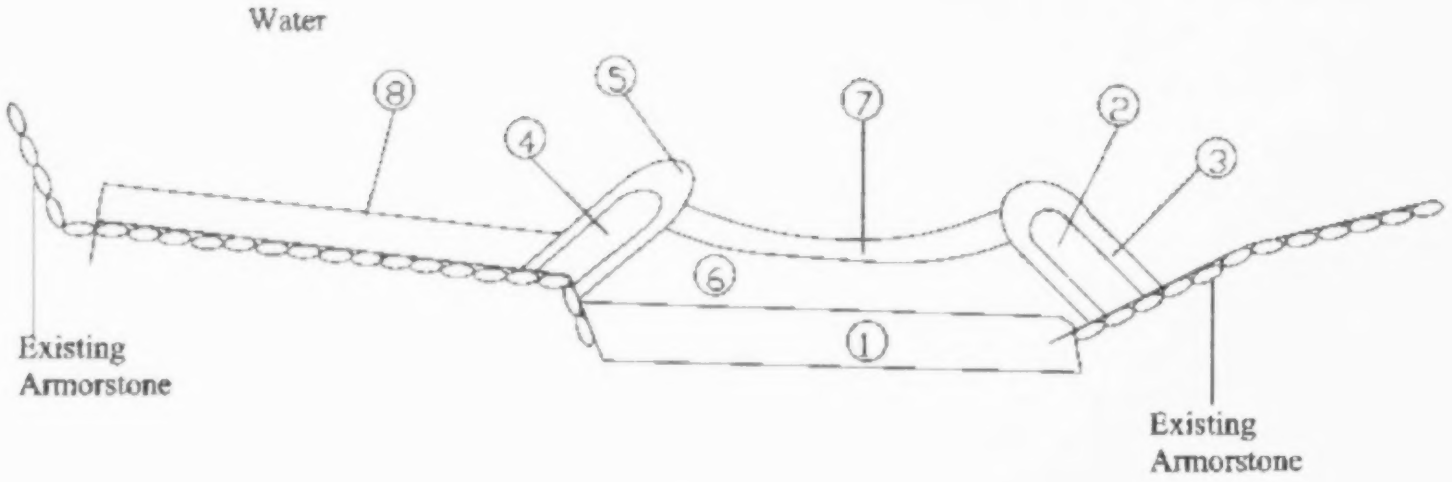
Proposal: Cobble beach between groynes.
Size of Compensation Area: 48 m^2.
Description of Work: (7) Cobble beach below average summer water level. Area modified 48 m^2.
Material Used: Cobble size rock 13 - 30 cm diameter.

HAAT Analysis

Assumptions: Size composition of shingle/cobble substrate in pre condition.
Results:

- Overall project resulted in a loss of fish habitat.
- No type of fish habitat experienced a gain, and the largest loss was in coldwater piscivore spawning habitat.
- Collectively spawning habitat suffered a larger loss over YOY and adult habitats.

Pre- and Post-Construction phase photographs not available



Case 8 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	34.5	LOSS		0-1	65% bedrock 20%cobble 15% rubble	no cover	1							stepped armourstone revetment
2	32	LOSS		0-1.5	65% bedrock 20%cobble 15% rubble	no cover	2							armourstone groyne
3	10	MODD		0-1.5	65% bedrock 20%cobble 15% rubble	no cover	3	10	MODD		0-1	100% boulder	no cover	armourstone groyne
4	20	LOSS		0-1.5	65% bedrock 20%cobble 15% rubble	no cover	4							armourstone groyne
5	10	MODD		0-1.5	65% bedrock 20%cobble 15% rubble	no cover	5	10	MODD		0-1	100% boulder	no cover	armourstone groyne
6	96	LOSS		0-1	65% bedrock 20%cobble 15% rubble	no cover	6							cobble beach
7	48	COMM		0-1.3	65% bedrock 20%cobble 15% rubble	no cover	7	48	COMM		0-1	50% cobble 25% rubble 25% boulder	no cover	cobble beach
8	58	LOSS		0-1	65% bedrock 20%cobble 15% rubble	no cover	8							stepped armourstone revetment

Case 8 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	34.5	LOSS		100	0	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
2	32	LOSS		70	30	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
3	10	MODD		70	30	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
4	20	LOSS		70	30	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
5	10	MODD		70	30	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
6	96	LOSS		100	0	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
7	48	COMM		80	20	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100
8	58	LOSS		100	0	0	0	0	100	65	0	20	15	0	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
3	10	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
5	10	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
7	48	COMM		100	0	0	0	0	100	0	25	50	25	0	0	0	0	0	100	0	0	100	100

Case 8 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-pisci. ores	0.17	16	3.7	-12.3
	Coldwater pisci. ores	0.17	0	0	0
	Coolwater non-pisci. ores	0.17	40.3	18.5	-21.8
	Coolwater pisci. ores	0.17	3.5	2	-1.5
	Warmwater non-pisci. ores	0.17	43.9	17.2	-26.7
	Warmwater pisci. ores	0.17	27.4	12.2	-15.2
Spawning	Coldwater non-pisci. ores	0.17	52.5	31.9	-20.6
	Coldwater pisci. ores	0.17	98.3	34.2	-64.1
	Coolwater non-pisci. ores	0.17	44.9	17.5	-27.4
	Coolwater pisci. ores	0.17	4.3	1	-3.3
	Warmwater non-pisci. ores	0.17	41.8	16.8	-25
	Warmwater pisci. ores	0.17	48.4	5.1	-43.3
YOY	Coldwater non-pisci. ores	0.17	22.3	12.8	-9.5
	Coldwater pisci. ores	0.17	17.6	4.2	-13.4
	Coolwater non-pisci. ores	0.17	17.7	1.9	-15.8
	Coolwater pisci. ores	0.17	0	0	0
	Warmwater non-pisci. ores	0.17	4.8	1.3	-3.5
	Warmwater pisci. ores	0.17	31.8	8.9	-22.9
Weighted Sum					
Adult		0.33	21.8	8.9	-12.9
Spawning		0.33	48.4	17.7	-30.7
YOY		0.33	15.7	4.8	-10.9
Over All Sum			28.6	10.5	-18.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	240.5	0	22.5	0	-22.5
MODD	20	20	1.8	2.1	0.3
MODI	-	-	-	-	-
COMM	48	48	4.4	8.4	4
COMC	-	-	-	-	-
TOTAL			28.7	10.5	-18.2

Case 9. Shoreline Stabilization, Hallowell Township, Bay of Quinte

Date Authorized: 1998/07/30
Project Location: Lake Ontario, Prescott District.

Project Activity

Proposal: Replace existing wood breakwall with steel sheeting and rock rip rap.
Size of Work Area (Area LOSS + MODD): 116.8 m^2.
Description of Work: (1) Area infilled behind steel wall 60 m long. Area lost 40 m^2.
(3) Area infilled by rock rip rap 80 m long on west side above the water line (elevation not specified). Area lost 30 m^2.
(4) Rock rip rap below water level on west side. Area modified 24 m^2.
(5) Area infilled by rock rip rap 7.6 m long on east side above the water line. Area lost 15.2 m^2.
(6) Rock rip rap on east side below water level. Area modified 7.6 m^2.
Material Used: Quarry stone 0.5 – 1.0 m diameter, placed on a 2:1 slope.

Pre Condition

Silty substrate, with some cobble and gravel patches nearshore. Water 0 - 1 m deep.

Indirect Effects

None.

Compensation

Proposal: Gravel toe placed at base of steel wall.
Size of Compensation Area: 60 m^2.
Description of Work: (2) Gravel toe at base of wall. Area modified 60 m^2.
Material Used: Gravel to be 10 - 15 cm diameter, and a minimum of 1 m wide.

HAAT Analysis

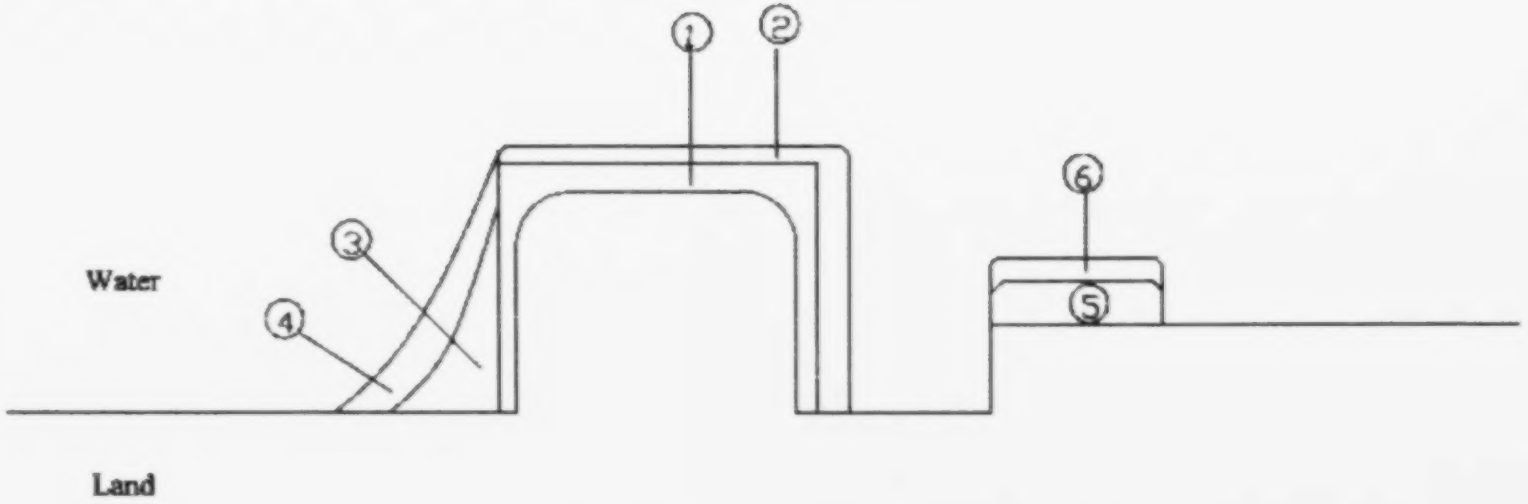
Assumptions: Estimated areas impacted by rip rap, using hand drawn sketch and photos. Estimated substrate sizes where rip rap was placed, from it being described as silty. Pre condition substrate in area filled for steel wall was determined with pictures of the area and existing substrate.

Results:

- Overall projects resulted in a net loss of fish habitat.
- Largest loss was for coolwater non-piscivore YOY habitat, and no fish habitat type experienced a gain.
- Collectively YOY habitat suffered the greatest losses over adult and spawning habitats.

Pre-Construction Phase

Post-Construction Phase



Case 9 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	40	LOSS		0-1	15% cobble 40% rubble, 40% gravel 5%silt	no cover	1							
2	60	COMM		0-1	10% cobble 35% rubble 30% gravel 25% silt	no cover	2	60	COMM		0-1	100% rubble	no cover	cement revetment
3	30	LOSS		0-1	25% rubble 20% gravel 55% silt	no cover	3							
4	24	MODD		0-1	25% rubble 20% gravel 55% silt	no cover	4	24	MODD		0-1	100% boulder	no cover	rock rip rap
5	15.2	LOSS		0-1	25% rubble 20% gravel 55% silt	no cover	5							
6	7.6	MODD		0-1	25% rubble 20% gravel 55% silt	no cover	6	7.6	MODD		0-1	100% boulder	no cover	rock rip rap

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	40	LOSS		100	0	0	0	0	100	0	0	15	40	40	0	5	0	0	100	0	0	100	100
2	60	COMM		100	0	0	0	0	100	0	0	10	35	30	0	25	0	0	100	0	0	100	100
3	30	LOSS		100	0	0	0	0	100	0	0	0	25	20	0	55	0	0	100	0	0	100	100
4	24	MODD		100	0	0	0	0	100	0	0	0	25	20	0	55	0	0	100	0	0	100	100
5	15.2	LOSS		100	0	0	0	0	100	0	0	0	25	20	0	55	0	0	100	0	0	100	100
6	7.6	MODD		100	0	0	0	0	100	0	0	0	25	20	0	55	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	60	COMM		100	0	0	0	0	100	0	0	0	100	0	0	0	0	0	100	0	0	100	100
4	24	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
6	7.6	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100

Case 9 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	25.4	9.4	-16
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	92.2	37.3	-54.9
	Coolwater piscivores	0.17	6.2	3.3	-2.9
	Warmwater non-piscivores	0.17	90	37.1	-52.9
	Warmwater piscivores	0.17	89.6	29.4	-60.2
Spawning	Coldwater non-piscivores	0.17	91.8	49.4	-42.4
	Coldwater piscivores	0.17	104.3	55.8	-48.5
	Coolwater non-piscivores	0.17	100.9	46.6	-54.3
	Coolwater piscivores	0.17	12.2	2.1	-10.1
	Warmwater non-piscivores	0.17	92.3	34.2	-58.1
	Warmwater piscivores	0.17	26.7	15.7	-11
YOY	Coldwater non-piscivores	0.17	56.7	18.9	-37.8
	Coldwater piscivores	0.17	73	21.2	-51.8
	Coolwater non-piscivores	0.17	101.6	8.7	-92.9
	Coolwater piscivores	0.17	14.2	0	-14.2
	Warmwater non-piscivores	0.17	27.1	5.7	-21.4
	Warmwater piscivores	0.17	36.1	15	-21.1
Weighted Sum					
Adult		0.33	50.6	19.4	-31.2
Spawning		0.33	71.4	34	-37.4
YOY		0.33	51.5	11.6	-39.9
Over All Sum			57.8	21.6	-36.2

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	85.2	0	28.2	0	-28.2
MODD	31.6	31.6	9.7	3.4	-6.3
MODI	-	-	-	-	-
COMM	60	60	19.9	18.3	-1.6
COMC	-	-	-	-	-
TOTAL			57.8	21.7	-36.1

Case 10. Shoreline Stabilization, Steel Sheet Wall, Small Craft Harbours, Georgian Bay

Date Authorized: 1998/11/30
Project Location: Lake Huron, Burlington District.

Project Activity
Proposal: Stabilize 22.4 m of shoreline with steel in an existing marina.
Size of Work Area (Area LOSS + MODD): 28.4 m^2.
Description of Work: (1) Area infilled for wall construction. Area lost 22.4 m^2.
(2) Area of armourstone boulder replacement. Area lost 6 m^2.
Material Used: Steel sheet pile wall.

Pre Condition
Substrate consisting of 5 - 10 cm rounded stones, 0.6 m deep.

Indirect Effects
None.

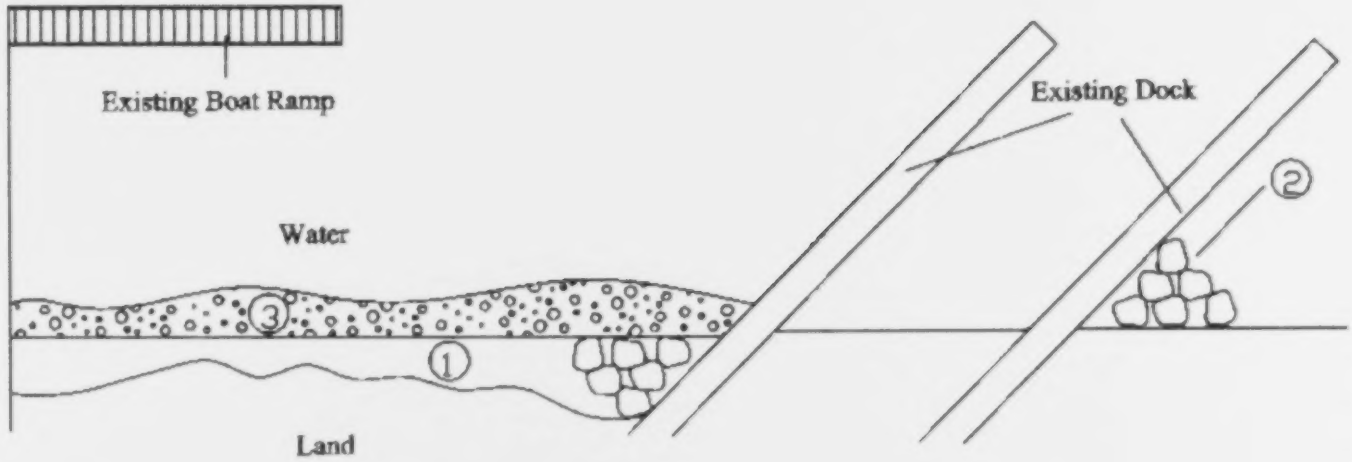
Compensation
Proposal: Rock toe at base of steel wall, 2:1 slope .
Size of Compensation Area: 16 m^2.
Description of Work: (3) Rock toe at base of wall. Area modified 16 m^2.
Material Used: Rock less than 10 cm diameter.

HAAT Analysis
Assumptions: Area of rock toe and boulder replacement estimated from sketches.
Results:

- Overall project resulted in a net loss of fish habitat.
- Largest loss for coldwater piscivore spawning fish habitat, no gains experienced in fish habitat.
- Collectively, spawning fish habitat suffered larger losses over YOY and adult habitat.

Pre-Construction phase photograph not available

Post-Construction Phase



Case 10 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	22.4	LOSS		0-0.6	20% boulder 56% rubble 24% gravel	no cover	1							steel retaining wall
2	6	LOSS		0.6	70% rubble 30% gravel	no cover	2							boulder relocation
3	16	COMM		0.6	70% rubble 30% gravel	no cover	3	16	COMM		0-1	50% rubble 50% gravel	no cover	rock toe

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate								*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	22.4	LOSS		100	0	0	0	0	100	0	20	0	56	24	0	0	0	0	100	0	0	100	100
2	6	LOSS		100	0	0	0	0	100	0	0	0	70	30	0	0	0	0	100	0	0	100	100
3	16	COMM		100	0	0	0	0	100	0	0	0	70	30	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate								*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
3	16	COMM		100	0	0	0	0	100	0	0	0	50	50	0	0	0	0	100	0	0	100	100

Case 10 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	2.8	1.2	-1.6
	Coldwater piscivores	0.17	0.9	0.4	-0.5
	Coolwater non-piscivores	0.17	29.4	12.7	-16.7
	Coolwater piscivores	0.17	3.1	1.3	-1.8
	Warmwater non-piscivores	0.17	22.9	9.6	-13.3
	Warmwater piscivores	0.17	19.3	8	-11.3
Spawning	Coldwater non-piscivores	0.17	32	13.1	-18.9
	Coldwater piscivores	0.17	36	14.5	-21.5
	Coolwater non-piscivores	0.17	33.3	13.9	-19.4
	Coolwater piscivores	0.17	2.9	1.1	-1.8
	Warmwater non-piscivores	0.17	23.9	11.3	-12.6
	Warmwater piscivores	0.17	9.8	3.9	-5.9
YOY	Coldwater non-piscivores	0.17	9.4	4.2	-5.2
	Coldwater piscivores	0.17	23.7	10.9	-12.8
	Coolwater non-piscivores	0.17	12.6	6.5	-6.1
	Coolwater piscivores	0.17	0.3	0.2	-0.1
	Warmwater non-piscivores	0.17	4.6	2.1	-2.5
	Warmwater piscivores	0.17	7.6	2.7	-4.9
Weighted Sum					
Adult		0.33	13.1	5.5	-7.6
Spawning		0.33	23	9.6	-13.4
YOY		0.33	9.7	4.4	-5.3
Over All Sum			15.3	6.5	-8.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	28.4	0	9.3	0	-9.3
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	16	16	5.9	6.5	0.6
COMC	-	-	-	-	-
TOTAL			15.2	6.5	-8.7

Case 11. Infilling, Halton County, Town of Oakville, Lake Ontario

Date Authorized: 1999/01/07
Project Location: Lake Ontario, Burlington District.

Project Activity
Proposal: Shoreline stabilization with a cobble revetment.
Size of Work Area (Area LOSS + MODD): 40 m^2.
Description of Work: (1) Cobble revetment above 75.3 m IGLD. Area lost 34.4 m^2. (2) Cobble revetment below water level. Area modified 5.6 m^2.
Material Used: Cobble 25 - 60 cm diameter.

Pre Condition
Substrate was fractured bedrock, with a beach composed of pieces of fractured bedrock and small rounded stones from 5 to 45 cm. Coldwater fisheries including lake trout. This section of Lake Ontario receives heavy winds and wave energy resulting in a large fetch from all directions, with an easterly component. Water 0 - 1 m depth.

Compensation
None.

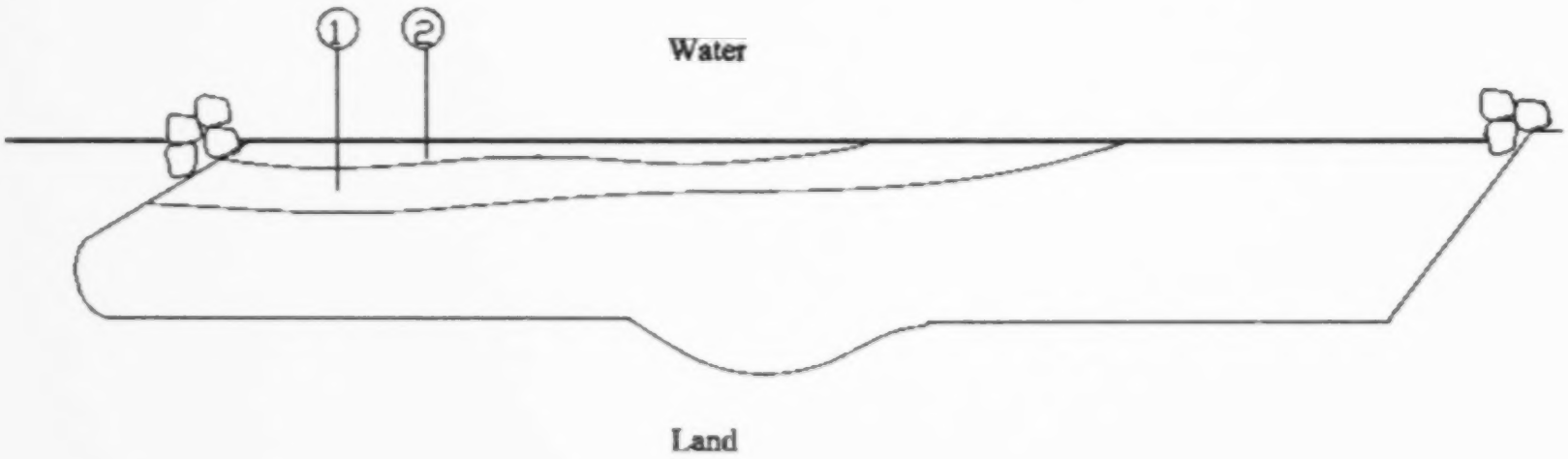
Indirect Effects
None.

HAAT Analysis
Assumptions: Percent composition of pre-condition substrate from the given range of 5 to 45 cm diameter stones.
Results:

- Overall, project resulted in a net loss of fish habitat.
- No gain in any type of fish habitat, and the largest loss was seen for the coldwater piscivores spawning habitat.
- Collectively, greatest losses were in spawning fish habitat over YOY and adult habitats.

Pre-Construction Phase

Post-Construction Phase



Case 11 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	34.4	LOSS		0-1	15% boulder 30% cobble 30% rubble 25% gravel	no cover								
2	5.6	MODD		0-1	15% boulder 30% cobble 30% rubble 25% gravel	no cover	2	5.6	MODD		0-1	100% boulder	no cover	cobble dynamic revetment

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	34.4	LOSS		100	0	0	0	0	100	0	15	30	30	25	0	0	0	0	100	0	0	100	100
2	5.6	MODD		100	0	0	0	0	100	0	15	30	30	25	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	5.6	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100

Case 11 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	4.1	0.2	-3.9
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	19.4	1.1	-18.3
	Coolwater piscivores	0.17	1.4	0.2	-1.2
	Warmwater non-piscivores	0.17	18.5	0.7	-17.8
	Warmwater piscivores	0.17	13.2	0.7	-12.5
Spawning	Coldwater non-piscivores	0.17	25.1	2.5	-22.6
	Coldwater piscivores	0.17	26.6	2.6	-24
	Coolwater non-piscivores	0.17	22.2	0.5	-21.7
	Coolwater piscivores	0.17	0.8	0.1	-0.7
	Warmwater non-piscivores	0.17	20.7	0.5	-20.2
	Warmwater piscivores	0.17	6	0.2	-5.8
YOY	Coldwater non-piscivores	0.17	11.3	1	-10.3
	Coldwater piscivores	0.17	13.1	0	-13.1
	Coolwater non-piscivores	0.17	8.7	0	-8.7
	Coolwater piscivores	0.17	0.2	0	-0.2
	Warmwater non-piscivores	0.17	3	0	-3
	Warmwater piscivores	0.17	5.9	0.7	-5.2
Weighted Sum					
Adult		0.33	9.4	0.5	-8.9
Spawning		0.33	16.9	1.1	-15.8
YOY		0.33	7	0.3	-6.7
Over All Sum			11.1	0.6	-10.5

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	34.4	-	9.6	0	-9.6
MODD	5.6	5.6	1.6	0.6	-1
MODI	-	-	-	-	-
COMM	-	-	-	-	-
COMC	-	-	-	-	-
TOTAL			11.2	0.6	-10.6

Case 12. Infilling, Mississauga, Peel TWP, Credit Valley, Lake Ontario

Date Authorized: 1999/02/09
Project Location: Lake Ontario, Burlington District.

Project Activity

Proposal: Stepped armourstone wall 3 rows high, to protect shoreline.
Size of Work Area (Area LOSS + MODD): 40.5 m^2.
Description of Work: (1) Top row of armourstone above the high water mark 75.8 IGLD. Area lost 29 m^2.
(2) Bottom two rows of armourstone below the high water mark. Area modified 11.5 m^2.
Material Used: Armourstone, 4 - 6 tonnes.

Pre Condition

Gabion baskets along shore. Shale bedrock covered by sand and shingle material. Water 0 –1 m deep.

Indirect Effects

None.

Compensation

Proposal: Every 6 m two additional toe stones excavated into lakebed excavated material placed between each of the toe stones creating a cobble beach.
Size of Compensation Area: 39.4 m^2.
Description of Work: (3) Total of 10 extra armourstone stones added along toe (no less than 74.2 m elevation). Area modified 12 m^2.
(4) Cobble beach. Area modified 27.4 m^2.
Material Used: Armourstone 4 - 6 tonnes, Cobble from excavated bedrock size not specified.

HAAT Analysis

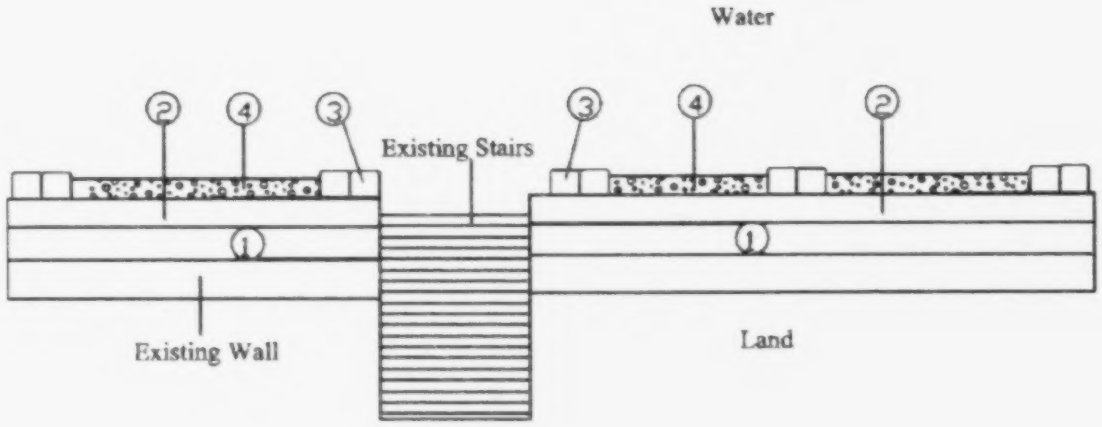
Assumptions: Percentage composition of existing substrate, given that it was a sand/shingle beach, and post construction cobble beach.
Results:

- Overall project resulted in a net loss of fish habitat.
- No gains in any type of fish habitat, largest losses for coolwater non-piscivore spawning habitat.
- Collectively, greatest loss seen in spawning fish habitat over adult and YOY habitats.

Case 12. Infilling, Mississauga, Peel TWP, Credit Valley, Lake Ontario

Pre-Construction Phase

Post-Construction Phase



Case 12 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	29	LOSS		0-1	10% cobble 40% rubble 30% gravel 20% sand	no cover	1							armourstone revetment
2	11.5	MODD		0-1	10% cobble 40% rubble 30% gravel 20% sand	no cover	2	11.5	MODD		0-1	100% boulder	no cover	armourstone revetment
3	12	COMM		0-1	10% cobble 40% rubble 30% gravel 20% sand	no cover	3	12	COMM		0-1	100% boulder	no cover	armourstone toe
4	27.4	COMM		0-1	10% cobble 40% rubble 30% gravel 20% sand	no cover	4	27.4	COMM		0-1	60% cobble 40% rubble	no cover	rock toe between armourstone toe

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	29	LOSS		100	0	0	0	0	100	0	0	10	40	30	20	0	0	0	100	0	0	100	100
2	11.5	MODD		100	0	0	0	0	100	0	0	10	40	30	20	0	0	0	100	0	0	100	100
3	12	COMM		100	0	0	0	0	100	0	0	10	40	30	20	0	0	0	100	0	0	100	100
4	27.4	COMM		100	0	0	0	0	100	0	0	10	40	30	20	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	11.5	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	12	COMM		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
4	27.4	COMM		100	0	0	0	0	100	0	0	50	50	0	0	0	0	0	100	0	0	100	100

Case 12 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	11.8	3.3	-8.5
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	52.9	15.1	-37.8
	Coolwater piscivores	0.17	3.1	1.6	-1.5
	Warmwater non-piscivores	0.17	49.1	14.2	-34.9
	Warmwater piscivores	0.17	38.8	10.5	-28.3
Spawning	Coldwater non-piscivores	0.17	59.7	24.6	-35.1
	Coldwater piscivores	0.17	53.5	26.7	-26.8
	Coolwater non-piscivores	0.17	61.3	15.4	-45.9
	Coolwater piscivores	0.17	4.3	0.8	-3.5
	Warmwater non-piscivores	0.17	56.5	13.6	-42.9
	Warmwater piscivores	0.17	16.4	4.7	-11.7
YOY	Coldwater non-piscivores	0.17	33.6	9.7	-23.9
	Coldwater piscivores	0.17	45.4	4.8	-40.6
	Coolwater non-piscivores	0.17	32.5	2.1	-30.4
	Coolwater piscivores	0.17	2.7	0	-2.7
	Warmwater non-piscivores	0.17	11	1.4	-9.6
	Warmwater piscivores	0.17	16.1	7	-9.1
Weighted Sum					
Adult		0.33	26	7.4	-18.6
Spawning		0.33	42	14.3	-27.7
YOY		0.33	23.6	4.2	-19.4
Over All Sum			30.5	8.6	-21.9

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	29	0	11.1	0	-11.1
MODD	11.5	11.5	4.4	1.2	3.2
MODI	-	-	-	-	-
COMM	39.4	39.4	15	7.4	-7.6
COMC	-	-	-	-	-
TOTAL			30.5	8.6	-21.9

Case 13. Armourstone groyne, City of Sarnia, Bright's Grove, Lake Huron

Date Authorized: 1999/08/04
Project Location: Lake Huron, Sarnia District.

Project Activity
Proposal: Replace steel wall, groyne and retaining wall with an armourstone groyne and armourstone revetment.
Size of Work Area (Area LOSS + MODD): 525 m^2.
Description of Work: (1) Area of T-shaped groyne above the high water mark 176.65 IGLD. Area lost 255 m^2.
(2) Armourstone groyne below the high water mark, lake-side slopes 2:1 and shore-side slopes 1.5:1. Area modified 270 m^2.
Armourstone revetment: Sand from the existing condition is cast over the lower portion of the revetment (at an elevation of 75.0 m) levelled and returned to the natural grade by wave action. So no part of the revetment will be at or below the high water mark and therefore no area lost.
Material Used: 2 - 5 tonne armourstone.

Pre Condition
Sand and gravel beach overlying clay. Most winds are onshore from the west to north, predominant offshore wind is from the southwest. Water 0 - 1.7 m deep supporting coldwater fisheries.

Indirect Effects
(3) Area protected on leeward side of T-shaped groyne, substrate and depth unchanged. Area modified indirectly 432 m^2.

Compensation
None.

HAAT Analysis
Assumptions: Areas estimated using paper weight method and scaled drawings.
Results:
Not Applying Indirect Effect

- Overall project resulted in a net loss of fish habitat.
- No gain for any fish habitat type, largest loss for warmwater non-piscivore spawning habitat.
- Collectively, spawning suffered from a greater loss of habitat over adult and YOY habitat types.

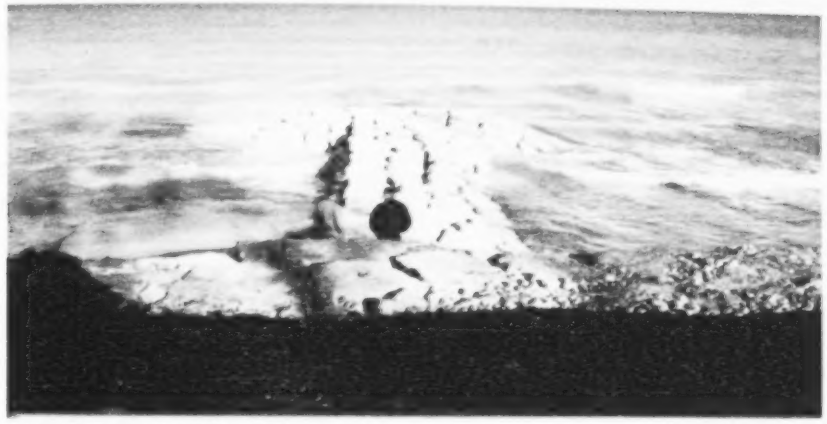
Case 13 (cont'd)

Applying Indirect Effect

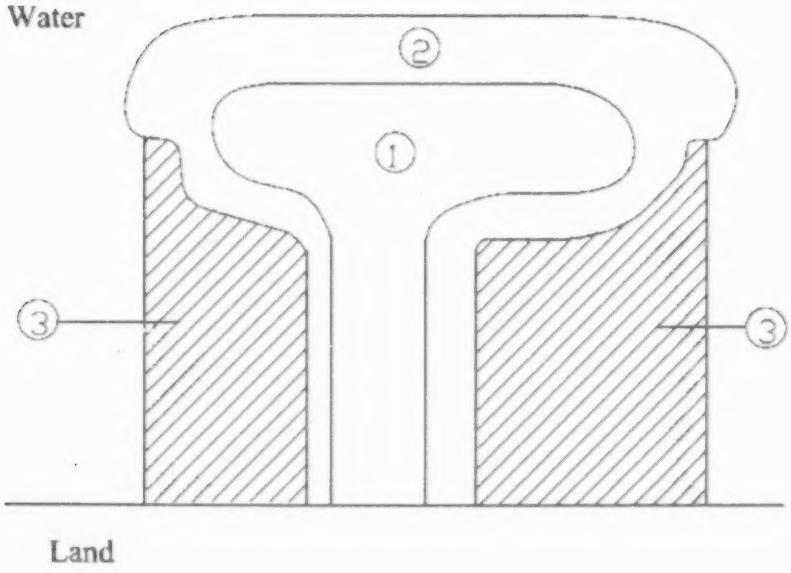
- Overall project resulted in a net loss of fish habitat, less than when indirect effect is not applied.
- No gain for any fish habitat type, largest loss for warmwater non-piscivore spawning habitat.
- Collectively, spawning suffered from a greater loss of habitat over adult and YOY habitat types.

Case 13. Armourstone Groyne, City of Sarnia, Bright's Grove, Lake Huron

Pre-Construction phase photograph not available



Post-Construction Phase



Case 13 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	255	LOSS	1.0	0-1.65	70% sand 30% gravel	no cover	1							armourstone groyne
2	270	MODD	0.64	0-1.65	70% sand 30% gravel	no cover	2	270	MODD	0.64	0-1.5	100% boulder	no cover	armourstone groyne
3	432	MODI	0.64	0-1	70% sand 30% gravel	no cover	3	432	MODI	1.0	0-1.65	70% sand 30% gravel	no cover	sheltering effect of groyne

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	255	LOSS	1.0	80	20	0	0	0	100	0	0	0	0	30	70	0	0	0	100	0	0	100	100
2	270	MODD	0.64	60	40	0	0	0	100	0	0	0	0	30	70	0	0	0	100	0	0	100	100
3	432	MODI	0.64	100	0	0	0	0	100	0	0	0	0	30	70	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	270	MODD	0.64	70	30	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	432	MODI	1.0	60	40	0	0	0	100	0	0	0	0	30	70	0	0	0	100	0	0	100	100

Case 13 (cont'd)
Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	78	39.7	-38.3
	Coldwater piscivores	0.17	29.7	13.4	-16.3
	Coolwater non-piscivores	0.17	901.5	476.1	-425.4
	Coolwater piscivores	0.17	124.5	67.2	-57.3
	Warmwater non-piscivores	0.17	598.2	300.8	-297.4
	Warmwater piscivores	0.17	598.5	304.6	-293.9
Spawning	Coldwater non-piscivores	0.17	760.7	410.5	-350.2
	Coldwater piscivores	0.17	571.5	330.3	-241.2
	Coolwater non-piscivores	0.17	721.8	297.7	-424.1
	Coolwater piscivores	0.17	158.8	72.7	-86.1
	Warmwater non-piscivores	0.17	747.5	281.4	-466.1
	Warmwater piscivores	0.17	177.2	90.4	-86.8
YOY	Coldwater non-piscivores	0.17	497.5	273.6	-223.9
	Coldwater piscivores	0.17	836.6	390.6	-446
	Coolwater non-piscivores	0.17	824.9	384.3	-440.6
	Coolwater piscivores	0.17	124.6	68.1	-56.5
	Warmwater non-piscivores	0.17	228.4	103.1	-125.3
	Warmwater piscivores	0.17	274.5	155.9	-118.6
Weighted Sum					
Adult		0.33	388.4	200.3	-188.1
Spawning		0.33	522.9	247.2	-275.7
YOY		0.33	458.6	225.6	-233
Over All Sum			458.6	240	-218.6

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	255	0	121.5	0	-121.5
MODD	270	270	124.1	27	-97.1
MODI	432	432	213	198.6	-14.4
COMM	-	-	-	-	-
COMC	-	-	-	-	-
TOTAL			458.6	225.6	-233

Case 13 (cont'd)
Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	57.4	38.1	-19.3
	Coldwater piscivores	0.17	21.8	13.4	-8.4
	Coolwater non-piscivores	0.17	663.4	451.2	-212.2
	Coolwater piscivores	0.17	91.6	63.2	-28.4
	Warmwater non-piscivores	0.17	440.3	289.8	-150.5
	Warmwater piscivores	0.17	440.4	292.2	-148.2
Spawning	Coldwater non-piscivores	0.17	558.5	370.4	-188.1
	Coldwater piscivores	0.17	420.6	304.3	-116.3
	Coolwater non-piscivores	0.17	529.2	284.5	-244.7
	Coolwater piscivores	0.17	116.6	69.2	-47.4
	Warmwater non-piscivores	0.17	547.8	274.7	-273.1
	Warmwater piscivores	0.17	130.4	86.7	-43.7
YOY	Coldwater non-piscivores	0.17	366.6	261.8	-104.8
	Coldwater piscivores	0.17	615.9	388.7	-227.2
	Coolwater non-piscivores	0.17	607.2	382	-225.2
	Coolwater piscivores	0.17	92	68.1	-23.9
	Warmwater non-piscivores	0.17	168.1	103.1	-65
	Warmwater piscivores	0.17	202	144.4	-57.6
Weighted Sum					
Adult		0.33	285.8	191.3	-94.5
Spawning		0.33	383.8	231.6	-152.2
YOY		0.33	342	224.7	-117.3
Over All Sum			337.2	215.9	-121.3

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	255	0	121.5	0	-121.5
MODD	172.8	172.8	79.4	17.3	-62.1
MODI	276.5	432	136.3	198.6	62.3
COMM	-	-	-	-	-
COMC	-	-	-	-	-
TOTAL			337.2	215.9	-121.3

Case 14. Shoreline Protection, Toronto, Lake Ontario

Date Authorized: 2000/04/11
Project Location: Lake Ontario, Burlington District.

Project Activity
Proposal: Shoreline Protection with an armourstone wall.
Size of Work Area (Area LOSS + MODD): 432 m^2.
Description of Work: (1) Armourstone wall elevated above the average water line 75.14 m IGLD. Area lost 170 m^2.
(2) Armourstone revetment below water line. Area modified 262 m^2.
Material Used: Armourstone 3 - 5 tonnes.

Pre Condition
All work done in 0 - 1.5 m water depth on bedrock substrate.

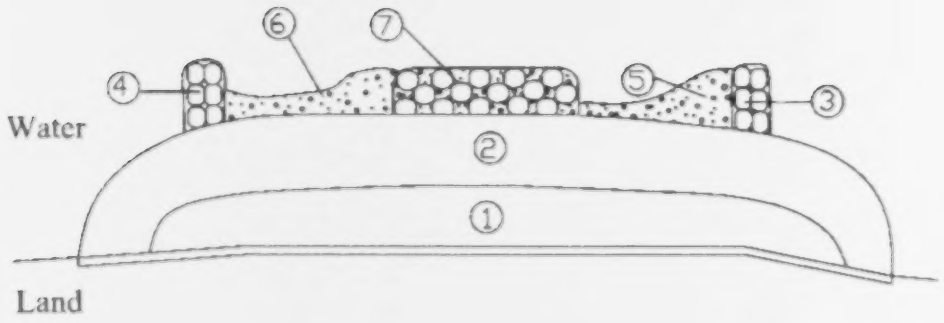
Indirect Effects
None.

Compensation
Proposal: Two armourstone groynes, an armourstone cobble checkerboard, and cobble toe.
Size of Compensation Area: 73 m^2.
Description of Work: (3) Armourstone groyne below water line. Area modified 6.5 m^2.
(4) Second armourstone groyne. Area modified 6.5 m^2.
(5) Cobble toe 10 m long. Area modified 15 m^2.
(6) Cobble toe 10 m long, area modified 15 m^2.
(7) Cobble-armourstone checkerboard, 10 m long by 3 m wide. Area modified 30 m^2.
Material Used: Armourstone 2 - 4 tonnes, and cobble 15 - 30 cm diameter.

HAAT Analysis
Assumptions: None
Results:

- Overall, project resulted in a net gain in fish habitat.
- Largest gain in coldwater non-piscivore spawning fish habitat, and largest loss in warmwater piscivore spawning habitat.
- In general the spawning habitat experienced the largest gain over YOY and adult habitats.

Pre- and Post-Construction phase photographs not available



Case 14 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	170	LOSS		0-1	100% bedrock	no cover	1							
2	262	MODD		0-2	100% bedrock	no cover	2	256	MODD		0-1.5	100% boulder	no cover	armourstone wall constructed
3	6.5	COMM		1-2.5	100% bedrock	no cover	3	6.5	COMM		0-1	100% boulder	no cover	armourstone groyne
4	6.5	COMM		1-2.5	100% bedrock	no cover	4	6.5	COMM		0-1	100% boulder	no cover	armourstone groyne
5	15	COMM		1-2.5	100% bedrock	no cover	5	15	COMM		0-2	85% cobble 15% boulder	no cover	cobble toe
6	15	COMM		1-2.5	100% bedrock	no cover	6	15	COMM		0-2	70% cobble 30% boulder	no cover	cobble toe
7	30	COMM		1-2.5	100% bedrock	no cover	7	30	COMM		0-2	70% cobble 30% boulder	no cover	boulder cobble mattress

Case 14 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	170	LOSS		100	0	0	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
2	262	MODD		20	80	0	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
3	6.5	COMM		0	20	80	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
4	6.5	COMM		0	20	80	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
5	15	COMM		0	20	80	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
6	15	COMM		0	20	80	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
7	30	COMM		0	20	80	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	262	MODD		80	20	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	6.5	COMM		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
4	6.5	COMM		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
5	15	COMM		70	30	0	0	0	100	0	15	85	0	0	0	0	0	0	100	0	0	100	100
6	15	COMM		70	30	0	0	0	100	0	30	70	0	0	0	0	0	0	100	0	0	100	100
7	30	COMM		70	30	0	0	0	100	0	30	70	0	0	0	0	0	0	100	0	0	100	100

Case 14 (cont'd)

Lake: Weighted Useable Areas m2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	18.6	12.3	-6.3
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	1.5	67.2	65.7
	Coolwater piscivores	0.17	0	9	9
	Warmwater non-piscivores	0.17	4.1	48.8	44.7
	Warmwater piscivores	0.17	0	42.8	42.8
Spawning	Coldwater non-piscivores	0.17	0	130	130
	Coldwater piscivores	0.17	95.4	155.6	60.2
	Coolwater non-piscivores	0.17	0	34.6	34.6
	Coolwater piscivores	0.17	5.6	3.7	-1.9
	Warmwater non-piscivores	0.17	2.3	36.9	34.6
	Warmwater piscivores	0.17	79.9	12.9	-67
YOY	Coldwater non-piscivores	0.17	0	58.4	58.4
	Coldwater piscivores	0.17	0	6.1	6.1
	Coolwater non-piscivores	0.17	23.6	0.2	-23.4
	Coolwater piscivores	0.17	0	0	0
	Warmwater non-piscivores	0.17	0	0.3	0.3
	Warmwater piscivores	0.17	39.8	39.6	-0.2
Weighted Sum					
Adult		0.33	4	30	26
Spawning		0.33	30.5	62.3	31.8
YOY		0.33	10.6	17.4	6.8
Over All Sum			15	36.6	21.6

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	170	0	5.3	0	-5.3
MODD	262	262	8.1	27.6	19.5
MODI	-	-	-	-	-
COMM	73	73	1.7	9	7.3
COMC	-	-	-	-	-
TOTAL			15.1	36.6	21.5

Case 15. Shoreline Protection, Town of Grimsby, 5th Street and Victoria Terrace, Lake Ontario

Date Authorized: 1999/11/10
Project Location: Lake Ontario, Burlington District.

Project Activity
Proposal: Stabilize two sections of eroding shoreline with armourstone groynes and revetments.
Size of Work Area (Area LOSS + MODD): 723.1 m^2 (439.5 m^2 at 5th street and 283.6 m^2 at Victoria Terrace).
Description of Work: ***5th Street*** (1) Armourstone revetment above 75.18 m IGLD. Area lost 269 m^2.
(2) Submerged portion of armourstone revetment. Area modified 170.5 m^2.
Victoria Terrace (4) Armourstone groyne above 74.78 m IGLD (minus footprint of existing groyne). Area lost 143.6 m^2.
(5) Submerged portion of armourstone groyne. Area modified 140 m^2.
Material Used: Blasted limestone, 2 - 5 tonne for the groyne and 2 - 4 tonne for the revetment.

Pre Condition
5th Street - Cobble/sand substrate, and water depth 0 – 1 m. Existing groyne to the east of proposed revetment.
Victoria Terrace - Cobble/sand substrate, and water depth 0 – 2 m. Existing groyne, 1.8 x 23 m, to be reconstructed and incorporated into core of proposed groyne.

Indirect Effects
Groyne rebuilt at Victoria Terrace imposes a sheltering effect from lake exposure affecting area (7).
(8) Area protected on leeward side of proposed groyne, water 0 – 1 m deep substrate unchanged. Area modified indirectly 111.4 m^2.

Compensation
Proposal: ***5th Street*** – Boulder clusters at toe of revetment.
Victoria Terrace – Boulder mattress to the east of the groyne.
Size of Compensation Area: 171 m^2 (52 m^2 at 5th street and 119 m^2 at Victoria Terrace).
Description of Work: ***5th Street*** (3) Toe of revetment composed of armourstone boulders individually placed. Cluster of 3 boulders periodically placed along toe of revetment and along existing groyne. Area modified 52 m^2.
Victoria Terrace (6) Toe of groyne using individually placed boulders. Area modified 19 m^2.
(7) Rock mattress 5 x 20 m. Area modified 100 m^2.

Case 15 (cont'd)

Material Used: Blasted limestone 2 - 4 tonne for toe stones and field boulders 30 – 60 cm diameter for rock mattress.

HAAT Analysis

Assumptions: Areas modified directly and lost by armourstone revetment and groyne were estimated using the paper weight method.

Results:

Not Applying Indirect Effect

- Overall project resulted in a loss of fish habitat.
- Largest loss of fish habitat in warmwater non-piscivore spawning habitat, and no fish habitat type experienced a gain.
- General trend of largest loss being in YOY habitat over adult and spawning habitats.

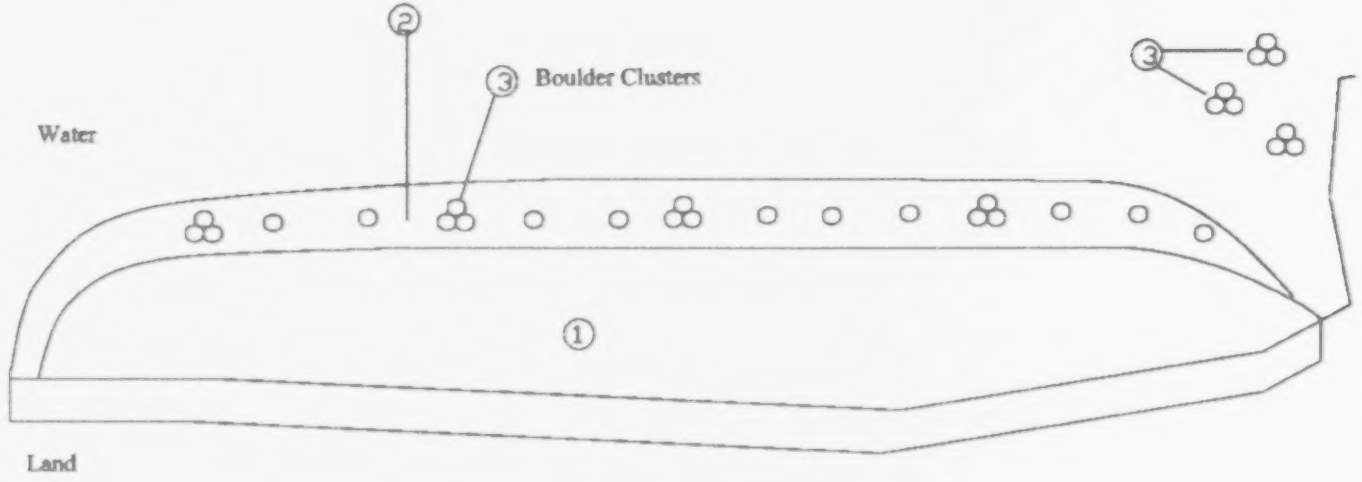
Applying Indirect Effect

- Overall project resulted in a loss of fish habitat, less than when indirect effect not applied.
- Largest loss of fish habitat in warmwater non-piscivore spawning habitat, and no fish habitat type experienced a gain.
- General trend of largest loss being in spawning habitat over adult and YOY habitats.

Case 15. Shoreline Protection, Town of Grimsby, 5th Street and Victoria Terrace, Lake Ontario, 5th Street Site

Pre-Construction Phase

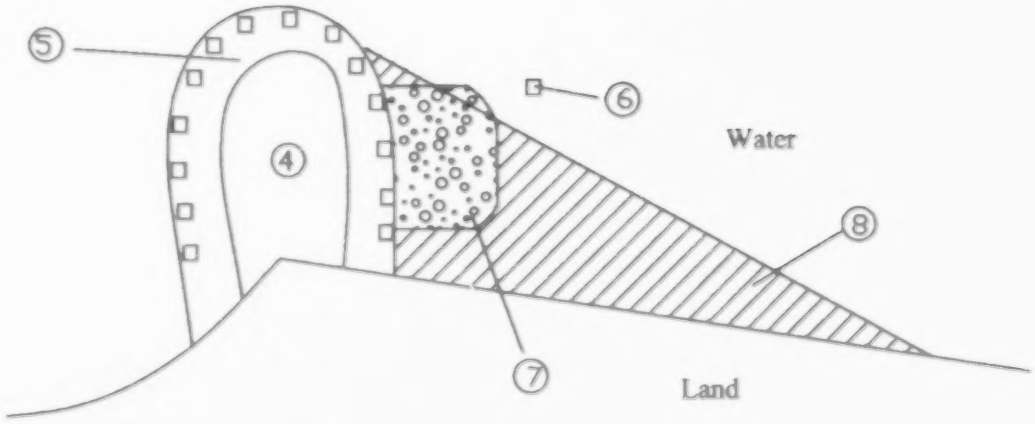
Post-Construction Phase



Case 15. Shoreline Protection, Town of Grimsby, 5th Street and Victoria Terrace, Lake Ontario, Victoria Terrace Site

Pre-Construction Phase

Post-Construction Phase



Case 15 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	269	LOSS	1.0	0-0.5	50% cobble 50% sand	no cover	1							armourstone revetment
2	170.5	MODD	0.64	0-1.5	50% cobble 50% sand	no cover	2	170.5	MODD	0.64	0-1	33.3% boulder 33.3%cobble 33.3%sand	no cover	armourstone revetment
3	52	COMM	0.64	0-1.5	50% cobble 50% sand	no cover	3	52	COMM	0.64	0.25	100% boulder	no cover	boulder clusters
4	143.6	LOSS	1.0	0-1	50% cobble 50% sand	no cover	4							armourstone groyne
5	140	MODD	0.64	0-2	50% cobble 50% sand	no cover	5	140	MODD	0.64	0-1	33.3%boulder 33.3%cobble 33.3%sand	no cover	armourstone groyne
6	19	COMM	0.64	0-2	50% cobble 50% sand	no cover	6	19	COMM	0.64	0.25	100% boulder	no cover	armourstone groyne
7	100	COMM	0.64	0-1.5	50% cobble 50% sand	no cover	7	100	COMM	1.0	0-1.3	100% boulder	no cover	rock mattress
8	111.4	MODI	0.64	0-1	50% cobble 50% sand	no cover	8	111.4	MODI	1.0	0-1	50% cobble 50% sand	no cover	sheltered effect of groyne

Case 15 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	269	LOSS	1.0	100	0	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
2	170.5	MODD	0.64	80	20	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
3	52	COMM	0.64	80	20	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
4	143.4	LOSS	1.0	100	0	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
5	140	MODD	0.64	80	20	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
6	19	COMM	0.64	90	10	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
7	100	COMM	0.64	70	30	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100
8	111.4	MODI	0.64	100	0	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	170.5	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	52	COMM	0.64	100	0	0	0	0	100	0	33.333	33.33	0	0	33.3	0	0	0	100	0	0	100	100
5	140	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
6	19	COMM	0.64	100	0	0	0	0	100	0	33.333	33.33	0	0	33.3	0	0	0	100	0	0	100	100
7	100	COMM	1.0	90	10	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
8	111.4	MODI	1.0	100	0	0	0	0	100	0	0	50	0	0	50	0	0	0	100	0	0	100	100

Case 15 (cont'd)

Not Applying Indirect Effect
Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	108.2	33.1	-75.1
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	528.8	167.1	-361.7
	Coolwater piscivores	0.17	33.8	17	-16.8
	Warmwater non-piscivores	0.17	464.9	128.4	-336.5
	Warmwater piscivores	0.17	387.9	116.7	-271.2
Spawning	Coldwater non-piscivores	0.17	605.7	289.2	-316.5
	Coldwater piscivores	0.17	357.6	258.4	-99.2
	Coolwater non-piscivores	0.17	464.3	118.5	-345.8
	Coolwater piscivores	0.17	82.3	18.6	-63.7
	Warmwater non-piscivores	0.17	533.9	129.1	-404.8
	Warmwater piscivores	0.17	100.4	32.6	-67.8
YOY	Coldwater non-piscivores	0.17	496.8	151	-345.8
	Coldwater piscivores	0.17	419.2	65.3	-353.9
	Coolwater non-piscivores	0.17	358.3	56.1	-302.2
	Coolwater piscivores	0.17	68	10.7	-57.3
	Warmwater non-piscivores	0.17	121.1	19.1	-102
	Warmwater piscivores	0.17	233.4	88.2	-145.2
Weighted Sum					
Adult		0.33	253.9	77.1	-176.8
Spawning		0.33	357.3	141.1	-216.2
YOY		0.33	282.8	65.1	-217.7
Over All Sum			298	94.4	-203.6

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	412.6	0	124.6	0	-124.6
MODD	310.5	311	90.5	33.3	-57.2
MODI	111.4	111.4	33.6	33.6	0
COMM	171	171	49.4	27.5	-21.9
COMC	-	-	-	-	-
TOTAL			298.1	94.4	-203.7

Case 15.

Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	85.3	26.8	-58.5
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	416.5	134.9	-281.6
	Coolwater piscivores	0.17	26.6	13.2	-13.4
	Warmwater non-piscivores	0.17	366.2	105.3	-260.9
	Warmwater piscivores	0.17	305.6	94.8	-210.8
Spawning	Coldwater non-piscivores	0.17	482.5	225.6	-256.9
	Coldwater piscivores	0.17	281.7	196.3	-85.4
	Coolwater non-piscivores	0.17	371.5	99.2	-272.3
	Coolwater piscivores	0.17	65.5	15.8	-49.7
	Warmwater non-piscivores	0.17	427	108.8	-318.2
	Warmwater piscivores	0.17	79.1	26.3	-52.8
YOY	Coldwater non-piscivores	0.17	389.6	122.1	-267.5
	Coldwater piscivores	0.17	328.7	58.4	-270.3
	Coolwater non-piscivores	0.17	281.8	50.1	-231.7
	Coolwater piscivores	0.17	53.6	9.6	-44
	Warmwater non-piscivores	0.17	95.4	17.1	-78.3
	Warmwater piscivores	0.17	183.8	70	-113.8
Weighted Sum					
Adult		0.33	200	62.5	-137.5
Spawning		0.33	284.5	112	-172.5
YOY		0.33	222.1	54.5	-167.6
Over All Sum			235.6	76.3	-159.3

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	412.6	0	124.6	0	-124.6
MODD	198.7	199	57.9	21.3	-36.6
MODI	71.3	111.4	21.5	33.6	12.1
COMM	109.4	145.4	31.6	21.4	-10.2
COMC	-	-	-	-	-
TOTAL			235.6	76.3	-159.3

Case 16. Dock, Infill, Cigar Island, Amabel TWP, Lake Huron

Date Authorized: 2000/05/03
Projects Location: Lake Huron.

Project Activity
Proposal: Extend existing dock by 6 m in length.
Size of Work Area (Area LOSS + MODD): 12 m^2.
Description of Work: (1) Dock extension with a 6 x 2 m steel crib. Area lost 12 m^2.
Material Used: Solid steel crib, filled with rock.

Pre Condition
Sandy substrate, water depths 0 to 1.2 m deep. Area receives high winds and waves. Coolwater fish, smallmouth bass and whitefish.

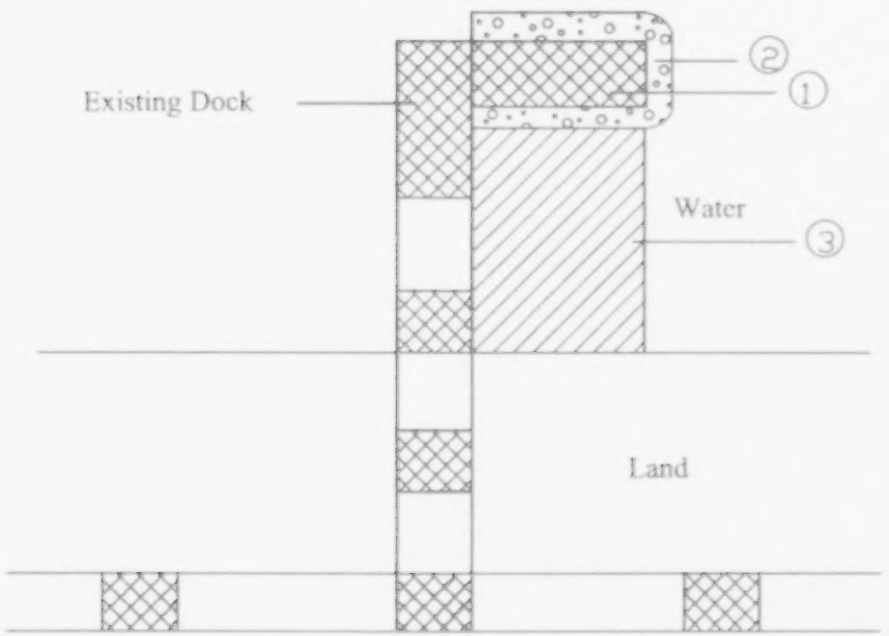
Indirect Effect
(3) Area receiving sheltering effect from lake exposure on leeward side of proposed dock. Area modified indirectly 80.52 m^2.

Compensation
Proposal: Place rock toe at base of steel crib.
Size of Compensation Area: 14 m^2.
Description of Work: (2) Rock toe at base of crib, 2:1 slope 0.3 m high from base of crib. Area modified 14 m^2.
Material Used: Rock 20 – 30 cm in diameter.

HAAT Analysis
Assumptions: None
Results:
Not Applying Indirect Effect
- Overall project resulted in a net loss of fish habitat.
- No habitat type experienced a gain, and the largest loss was for coolwater non-piscivore YOY habitat.
- Collectively, YOY fish habitat experienced a larger loss over adult and spawning habitats.

Applying Indirect Effect
- Overall project resulted in a net loss of fish habitat, less than when indirect effect not applied.
- No habitat type experienced a gain, and the largest loss was for coolwater non-piscivore YOY habitat.
- Collectively, YOY fish habitat experienced a larger loss over adult and spawning habitats.

Pre- and Post-Construction phase photographs not available



Case 16 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	12	LOSS	1.0	0-1.2	100% sand	no cover	1							solid steel crib of dock
2	14	COMM	0.64	0-1.2	100% sand	no cover	2	14	COMM	0.64	0-1.2	50% cobble 50% boulder	no cover	rock toe
3	80.52	MODI	0.64	0-1.2	100% sand	no cover	3	80.52	MODI	1.0	0-1.2	100% sand	no cover	reduced wind and wave effect

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	12	LOSS	1.0	90	10	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
2	14	COMM	0.64	90	10	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
3	80.5	MODI	0.64	90	10	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	14	COMM	0.64	90	10	0	0	0	100	0	50	50	0	0	0	0	0	0	100	0	0	100	100
3	80.5	MODI	0.64	90	10	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

Case 16 (cont'd)

Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	8.7	6.8	-1.9
	Coldwater piscivores	0.17	3.3	2.5	-0.8
	Coolwater non-piscivores	0.17	97.7	77.9	-19.8
	Coolwater piscivores	0.17	15.2	12	-3.2
	Warmwater non-piscivores	0.17	62.8	49.9	-12.9
	Warmwater piscivores	0.17	68.6	53.6	-15
Spawning	Coldwater non-piscivores	0.17	81.7	68.7	-13
	Coldwater piscivores	0.17	45.2	37.9	-7.3
	Coolwater non-piscivores	0.17	79.1	63.1	-16
	Coolwater piscivores	0.17	22.9	17.9	-5
	Warmwater non-piscivores	0.17	84.4	66.1	-18.3
	Warmwater piscivores	0.17	17.1	13.5	-3.6
YOY	Coldwater non-piscivores	0.17	59.8	47	-12.8
	Coldwater piscivores	0.17	90.7	68.5	-22.2
	Coolwater non-piscivores	0.17	101.3	77	-24.3
	Coolwater piscivores	0.17	17	12.8	-4.2
	Warmwater non-piscivores	0.17	28.6	21.7	-6.9
	Warmwater piscivores	0.17	36.9	29.5	-7.4
Weighted Sum					
Adult		0.33	42.7	33.8	-8.9
Spawning		0.33	55.1	44.5	-10.6
YOY		0.33	55.7	42.8	-12.9
Over All Sum			51.2	40.4	-10.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	12	0	5.8	0	-5.8
MODD	-	-	-	-	-
MODI	80.5	80.5	38.7	38.7	0
COMM	14	14	6.7	1.7	-5
COMC	-	-	-	-	-
TOTAL			51.2	40.4	-10.8

Case 16 (cont'd)
Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5.9	4.3	-1.6
	Coldwater piscivores	0.17	2.2	1.6	-0.6
	Coolwater non-piscivores	0.17	66.5	49.8	-16.7
	Coolwater piscivores	0.17	10.3	7.7	-2.6
	Warmwater non-piscivores	0.17	42.7	32	-10.7
	Warmwater piscivores	0.17	46.7	34.3	-12.4
Spawning	Coldwater non-piscivores	0.17	55.6	43.9	-11.7
	Coldwater piscivores	0.17	30.8	24.3	-6.5
	Coolwater non-piscivores	0.17	53.8	40.4	-13.4
	Coolwater piscivores	0.17	15.6	11.5	-4.1
	Warmwater non-piscivores	0.17	57.4	42.3	-15.1
	Warmwater piscivores	0.17	11.7	8.6	-3.1
YOY	Coldwater non-piscivores	0.17	40.7	30.1	-10.6
	Coldwater piscivores	0.17	61.7	43.9	-17.8
	Coolwater non-piscivores	0.17	69	49.3	-19.7
	Coolwater piscivores	0.17	11.6	8.2	-3.4
	Warmwater non-piscivores	0.17	19.5	13.9	-5.6
	Warmwater piscivores	0.17	25.1	18.9	-6.2
Weighted Sum					
Adult		0.33	29.1	21.6	-7.5
Spawning		0.33	37.5	28.5	-9
YOY		0.33	37.9	27.4	-10.5
Over All Sum			34.8	25.8	-9

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	12	0	5.8	0	-5.8
MODD					
MODI	51.5	51.5	24.8	24.8	0
COMM	9	9	4.3	1.1	-3.2
COMC					
TOTAL			34.9	25.9	-9

Case 17. Infill, Dawson Twp, Mississagi Strait, Lake Huron

Date Authorized: 2000/11/03
Project Location: Lake Huron, Sudbury District.

Project Activity
Proposal: Expand existing loading dock using retaining wall, revetments and 3 bollards.
Size of Work Area (Area LOSS + MODD): 7,585 m^2.
Description of Work: (1) Infill area of retaining walls, revetment and back fill, above high water mark 175.67 m IGLD. Area lost 5,943 m^2.
(2) Revetment 1.5:1 slope below high water mark. Area modified 1,487 m^2.
Material Used: Angular quarrystone 10 - 15 tonnes for retaining wall, 7.5 tonnes for revetment.

Pre Condition
Shallow area of 0 - 3 m extending 1 to 20 m out from shore with a steep drop off to 10 – 70 m depth. Predominantly cobble substrate (1 - 6") and gravel in shallow area. Drop off consisted of bedrock ledges and broken off rubble.

Indirect Effects
Breakwaters constructed in the compensation area to the south of loading dock, act to shelter the compensation area from wave exposure, affecting areas (9) (10) (11) (12) and (13).
(14) Area protected on leeward side of breakwaters minus the area occupied by compensation features, substrate and depth unchanged. Area modified indirectly 188 m^2.

Compensation
Proposal: Compensate for loss with a series of breakwaters and the placement of various rootwads, tree crowns, logs, crib caves, and vegetation areas.
Size of Compensation Area: 1,235 m^2
Description of Work: Compensation in two locations: in the area of infilling on the revetments between bollards and a site south of the infill protected by 4 breakwaters.
Site south of infilling
(6) South 'single J' breakwater, 15 m long, is perpendicular to the shore and 2 m out from the current water line. Extends 1.5 m above the current water level and out to the 3.5 m contour line. Area lost 45 m^2.
(7) Two 'double J' breakwaters, parallel to the shore, are 20 m long and run along the 2 m contour line. Area modified 80 m^2.
(8) 'Single J' breakwater, 15 m long. Area modified 30 m^2.
(9) 6 crib caves each 12 m^2 and 1.8 m high. Area modified 72 m^2.
(10) Additional logs placed between vegetated areas. Area modified 70 m^2.
(11) Vegetated areas composed of silty sand and some clay with rich organic component. Areas contained by boulder border 20 cm in height. Each area constructed in 1 to 2 m of water. Two areas modified are 150 m^2 and one is 225 m^2.

Case 17 (cont'd)

(12) 11 tree crowns. Area modified 200 m^2.
(13) 15 rootwads. Area modified 100 m^2.
Infill site
(3) 4 log cribs caves each 2 m high. Area modified 48 m^2.
(4) 10 rootwads. Area modified 70 m^2.
(5) 8 tree crowns. Area modified 150 m^2.
Material Used: Southern most breakwall constructed with 3 m cubed armourstone, remaining breakwalls constructed with 2 m cubed blocks. Crib caves constructed out of hemlock or cedar logs, with pea gravel as substrate inside. Rootwads and additional taken from local trees in area, and the tree crowns from evergreens in the area. Planting pockets consist of species native to Manitoulin including water lily, smartweed, tapegrass, pondweed sp., cattail sp. and bulrush.

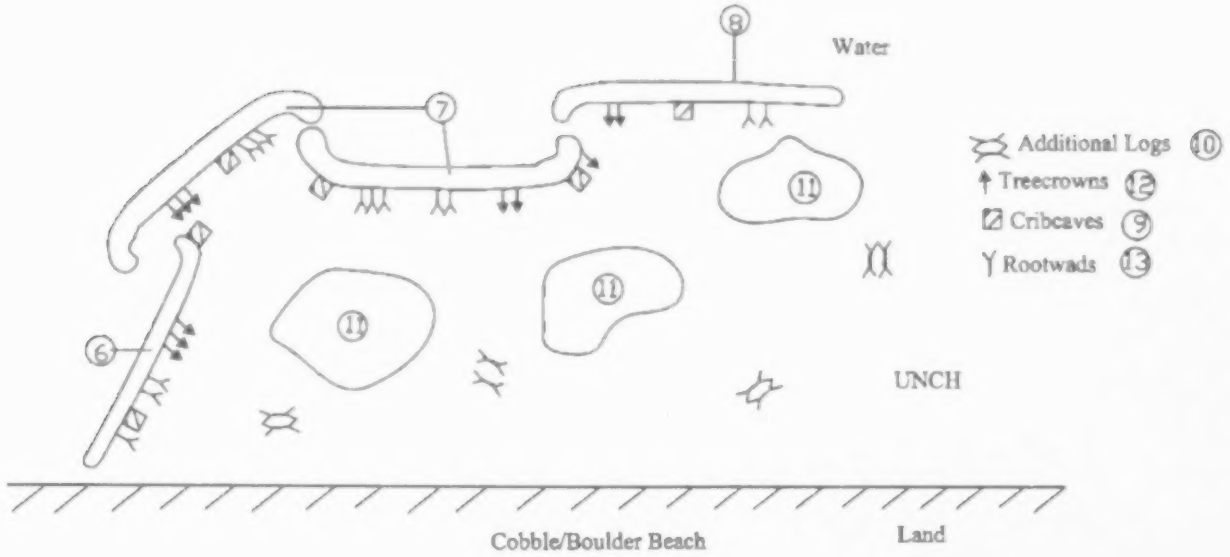
HAAT Results
Assumptions: Areas modified and lost estimated using scaled drawings and paper weight method. Area modified indirectly estimated using dimensions of breakwaters and distance between breakwaters.
Results:
Not Applying Indirect Effect
- Overall project resulted in a net loss of fish habitat.
- Largest gain for coolwater piscivore adult habitat, and largest loss for coldwater piscivore YOY habitat.
- Collectively, spawning habitat suffered from a greater loss over adult and YOY habitat.

Applying Indirect Effect
- Overall project resulted in a net loss of fish habitat, less than when the indirect effect is not applied.
- Largest gain for warmwater non-piscivore YOY habitat, and largest loss for coldwater non-piscivore spawning habitat.
- Collectively, spawning habitat suffered from a greater loss over adult and YOY habitats.

Case 17. Infill, Dawson Township, Mississagi Strait, Lake Huron, Compensation Site

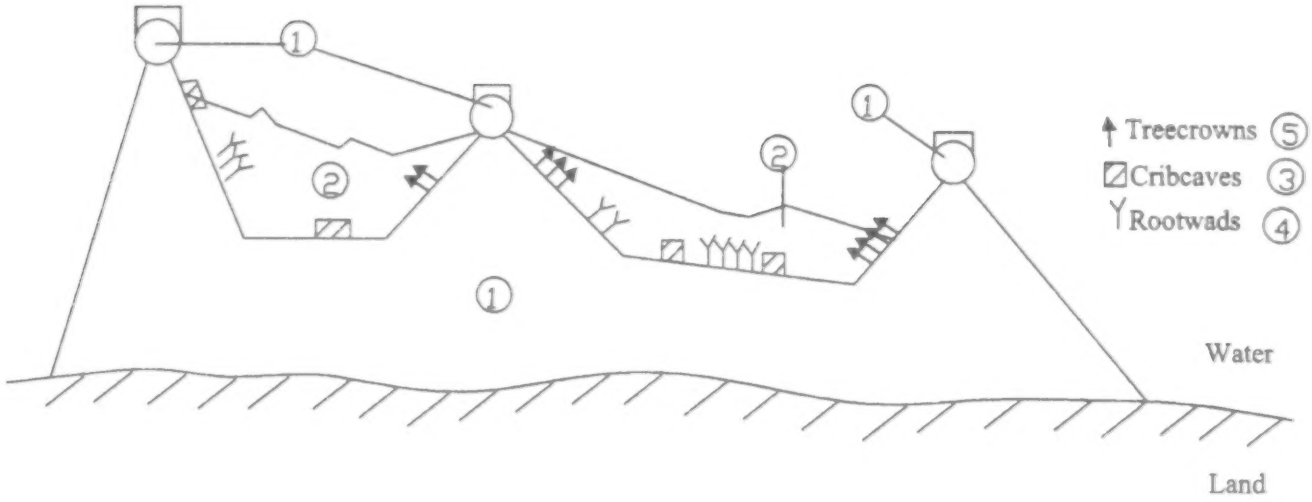
Pre-Construction phase photograph not available

Post-Construction Phase



Pre-Construction phase photograph not available

Post-Construction Phase



Case 17 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	5,943	LOSS	1	0-20	10% bedrock 15% boulder 35% cobble 30% rubble 10% gravel	no cover	1							loading dock and revetment
2	1,487	MODD	0.64	2-15	10% bedrock 15% boulder 35% cobble 30% rubble 10% gravel	no cover	2	1,487	MODD	0.64	0-15	100% boulder	no cover	armourstone revetment
3	48	COMM	0.64	5-15	10% bedrock 15% boulder 35% cobble 30% rubble 10% gravel	no cover	3	48	COMM	0.64	3-15	55% gravel 45% sand	30% submergent 70% no cover	4 crib caves
4	70	COMM	0.64	2-15	10% bedrock 15% boulder 35% cobble 30% rubble 10% gravel	no cover	4	70	COMM	0.64	2-15	100% boulder	25% emergent 25% submergent 50% no cover	10 rootwads
5	150	COMM	0.64	2-15	10% bedrock 15% boulder 35% cobble 30% rubble 10% gravel	no cover	5	150	COMM	0.64	2-15	100% boulder	25% emergent 25% submergent 50% no cover	8 tree crowns
6	45	LOSS	1	1-10	55% rubble 45% gravel	no cover	6							breakwater
7	80	MODD	0.64	2-10	55% rubble 45% gravel	no cover	7	80	MODD	0.64	0-1	100% boulder	no cover	breakwater
8	30	MODD	0.64	2-12	55% rubble 45% gravel	no cover	8	30	MODD	0.64	0-1	100% boulder	no cover	breakwater
9	72	COMM	0.64	0-10	55% rubble 45% gravel	no cover	9	72	COMM	1	0-4	55% gravel 45% sand	30% submergent 70% no cover	6 crib caves
10	70	COMM	0.64	0-2	55% rubble 45% gravel	no cover	10	70	COMM	1	0-2	55% rubble 45% gravel	25% submergent 75% no cover	4 additional logs
11	525	COMM	0.64	0-5	55% rubble 45% gravel	no cover	11	525	COMM	1	0-5	10% cobble 35% sand 45% silt 10% clay	40% emergent 40% submergent 20% no cover	vegetation planting pockets
12	200	COMM	0.64	0-5	55% rubble 45% gravel	no cover	12	200	COMM	1	0-5	55% rubble 45% gravel	25% emergent 25% submergent 50% no cover	11 tree crowns
13	100	COMM	0.64	0-5	55% rubble 45% gravel	no cover	13	100	COMM	1	0-5	55% rubble 45% gravel	25% emergent 25% submergent 50% no cover	15 rootwads
14	188	MODI	0.64	0-5	55% rubble 45% gravel	no cover	14	188	MODI	1	0-5	55% rubble 45% gravel	no cover	shelter effect from breakwaters

Case 17 (cont'd)

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	5943	LOSS	1	20	10	25	20	25	100	10	15	35	30	10	0	0	0	0	100	0	0	100	100
2	1487	MODD	0.64	0	0	10	60	30	100	10	15	35	30	10	0	0	0	0	100	0	0	100	100
3	48	COMM	0.64	0	0	0	90	10	100	10	15	35	30	10	0	0	0	0	100	0	0	100	100
4	70	COMM	0.64	0	0	10	70	20	100	10	15	35	30	10	0	0	0	0	100	0	0	100	100
5	150	COMM	0.64	0	0	25	50	25	100	10	15	35	30	10	0	0	0	0	100	0	0	100	100
6	45	LOSS	1	0	10	30	60	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
7	80	MODD	0.64	0	0	80	20	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
8	30	MODD	0.64	0	0	30	60	10	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
9	72	COMM	0.64	15	35	50	40	0	140	0	0	0	55	45	0	0	0	0	100	0	0	100	100
10	70	COMM	0.64	75	25	0	0	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
11	525	COMM	0.64	30	60	10	0	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
12	200	COMM	0.64	20	20	60	0	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
13	100	COMM	0.64	20	40	40	0	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100
14	188	MODI	0.64	20	40	40	0	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	1487	MODD	0.64	20	20	20	20	20	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	48	COMM	0.64	0	0	20	70	10	100	0	0	0	0	55	45	0	0	0	100	30	0	70	100
4	70	COMM	0.64	0	0	20	60	20	100	0	100	0	0	0	0	0	0	0	100	25	25	50	100
5	150	COMM	0.64	0	10	30	45	15	100	0	100	0	0	0	0	0	0	0	100	25	25	50	100
7	80	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
8	30	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
9	72	COMM	1	15	35	50	0	0	100	0	0	0	0	55	45	0	0	0	100	30	0	70	100
10	70	COMM	1	75	25	0	0	0	100	0	0	0	55	45	0	0	0	0	100	25	25	50	100
11	525	COMM	1	30	60	10	0	0	100	0	0	10	0	0	35	45	10	0	100	40	40	20	100
12	200	COMM	1	20	20	60	0	0	100	0	0	0	55	45	0	0	0	0	100	25	25	50	100
13	100	COMM	1	20	40	40	0	0	100	0	0	0	55	45	0	0	0	0	100	25	25	50	100
14	188	MODI	1	20	40	40	0	0	100	0	0	0	55	45	0	0	0	0	100	0	0	100	100

Case 17 (cont'd)
Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	784.7	203.4	-581.3
	Coldwater piscivores	0.17	202.6	36.4	-166.2
	Coolwater non-piscivores	0.17	1901.9	778.1	-1123.8
	Coolwater piscivores	0.17	384.4	500.4	116
	Warmwater non-piscivores	0.17	1474.9	705.6	-769.3
	Warmwater piscivores	0.17	2080	824.9	-1255.1
Spawning	Coldwater non-piscivores	0.17	3653.9	897.9	-2756
	Coldwater piscivores	0.17	3143.9	702.6	-2441.3
	Coolwater non-piscivores	0.17	1030.6	341.8	-688.8
	Coolwater piscivores	0.17	299.4	234.8	-64.6
	Warmwater non-piscivores	0.17	762.8	395.2	-367.6
	Warmwater piscivores	0.17	687.4	459.4	-228
YOY	Coldwater non-piscivores	0.17	3218	886.2	-2331.8
	Coldwater piscivores	0.17	3546.6	739.8	-2806.8
	Coolwater non-piscivores	0.17	865.6	502.9	-362.7
	Coolwater piscivores	0.17	163.8	195.2	31.4
	Warmwater non-piscivores	0.17	302.9	399	96.1
	Warmwater piscivores	0.17	1168.5	530.1	-638.4
Weighted Sum					
Adult		0.33	1138.1	508.1	-630
Spawning		0.33	1596.3	505.3	-1091
YOY		0.33	1544.2	542.2	-1002
Over All Sum			1426.2	518.5	-907.7

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	5988	0	834.2	0	-834.2
MODD	1597	1597	195.1	158.8	-36.3
MODI	188	188	54.9	54.9	0
COMM	1263.8	1235	342	304.8	-37.2
COMC	-	-			-
TOTAL			1426.2	518.5	-907.7

Case 17 (cont'd)
Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	675.6	155.8	-519.8
	Coldwater piscivores	0.17	171	28.3	-142.7
	Coolwater non-piscivores	0.17	1599.1	702.4	-896.7
	Coolwater piscivores	0.17	325.5	475.2	149.7
	Warmwater non-piscivores	0.17	1235.1	664.8	-570.3
	Warmwater piscivores	0.17	1738.2	747.1	-991.1
Spawning	Coldwater non-piscivores	0.17	3167.4	681	-2486.4
	Coldwater piscivores	0.17	2676.6	572.9	-2103.7
	Coolwater non-piscivores	0.17	891.4	303.7	-587.7
	Coolwater piscivores	0.17	260.7	216.9	-43.8
	Warmwater non-piscivores	0.17	655.7	375.6	-280.1
	Warmwater piscivores	0.17	584.3	433.6	-150.7
YOY	Coldwater non-piscivores	0.17	2759.5	659.3	-2100.2
	Coldwater piscivores	0.17	2995.8	610	-2385.8
	Coolwater non-piscivores	0.17	700.2	492.4	-207.8
	Coolwater piscivores	0.17	131.2	193.3	62.1
	Warmwater non-piscivores	0.17	249.3	398.4	149.1
	Warmwater piscivores	0.17	1019	456	-563
Weighted Sum					
Adult		0.33	957.4	462.3	-495.1
Spawning		0.33	1372.7	430.6	-942.1
YOY		0.33	1309.2	468.2	-841
Over All Sum			1213.1	453.7	-759.4

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	5988	0	834.2	0	-834.2
MODD	1022.1	1022.1	124.8	101.6	-23.2
MODI	120.3	188	35.1	54.9	19.8
COMM	808.8	1138.5	218.9	297.2	78.3
COMC	-	-	-	-	-
TOTAL			1213	453.7	-759.3

Case 18. Shoreline Protection, Town of Grimsby, Lake Ontario

Date Authorized: 2000/09/12
Project Location: Lake Ontario, Burlington District.

Project Activity

Proposal: Shoreline protection with a 22 m long armourstone retaining wall.
Size of Work Area: 55 m^2.
Description of Work: (1) Armourstone retaining wall above the high water mark 75.18 m IGLD. Area lost 36 m^2.
(2) Armourstone wall below high water mark. Area modified 19 m^2.
Material Used: Armourstone blocks.

Pre Condition

Vertical bluffs with a shale bedrock base. Warm/cool water, 0 - 0.61 m deep.

Indirect Effects

None.

Compensation

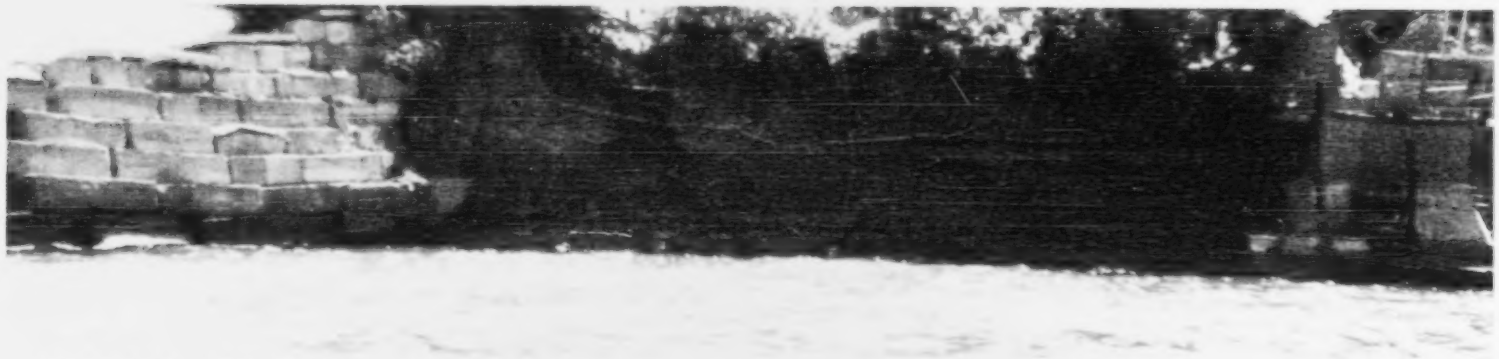
Proposal: Rock toe in front of retaining wall and three areas of boulder clusters.
Size of Compensation Area: 40.6 m^2.
Description of Work: (3) Rock mattress placed along the nearshore lakebed. Area modified 34.6 m^2.
(4) Three Boulder clusters placed along the shore in front of the retaining wall. Area modified 6 m^2.
Material Used: Boulders up to 100 cm diameter. Crushed clean limestone rubble 10 - 30 cm diameter.

HAAT Analysis

Assumptions: Area of compensation estimated from a sketch (not to scale) and ruler. Percent composition of substrate estimated for the precondition and the rock mattress.
Results:

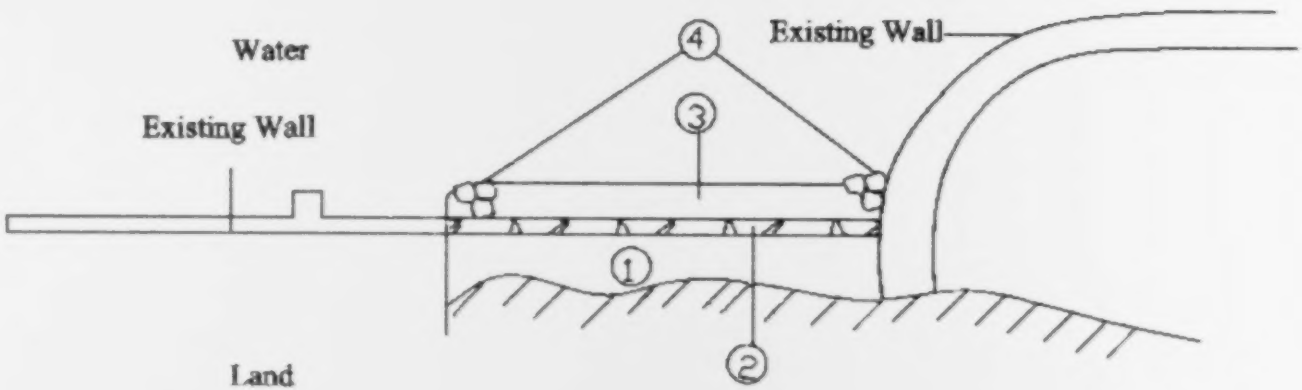
- Overall project resulted in a net gain of fish habitat.
- Largest gain for coldwater non-piscivore spawning habitat, and largest loss for warmwater piscivore spawning fish habitat.
- Collectively, spawning habitat experienced the largest gain in fish habitat over YOY and adult habitats.

Case 18. Shoreline Protection, Town of Grimsby, Lake Ontario



Pre-Construction Phase

Post-Construction phase photograph not available



Case 18 (cont'd)

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	36	LOSS		0-1	70% bedrock 20% boulder 10% cobble	no cover	1							armourstone retaining wall
2	19	MODD		0-1	70% bedrock 20% boulder 10% cobble	no cover	2	19	MODD		0-1	100% boulder	no cover	armourstone retaining wall
3	34.6	COMM		0-1	70% bedrock 20% boulder 10% cobble	no cover	3	34.6	COMM		0-1	10% boulder 75% cobble 15% rubble	no cover	rock mattress
4	6	COMM		0-1	70% bedrock 20% boulder 10% cobble	no cover	4	6	COMM		0-1	100% boulder	no cover	boulder clusters

PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	36	LOSS		100	0	0	0	0	100	70	20	10	0	0	0	0	0	0	100	0	0	100	100
2	19	MODD		100	0	0	0	0	100	70	20	10	0	0	0	0	0	0	100	0	0	100	100
3	34.6	COMM		100	0	0	0	0	100	70	20	10	0	0	0	0	0	0	100	0	0	100	100
4	6	COMM		100	0	0	0	0	100	70	20	10	0	0	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	19	MODD		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3	34.6	COMM		100	0	0	0	0	100	0	10	75	15	0	0	0	0	0	100	0	0	100	100
4	6	COMM		100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100

Case 18 (cont'd)

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	3.5	2.7	-0.8
	Coldwater piscivores	0.17	0	0	0
	Coolwater non-piscivores	0.17	6.3	14.7	8.4
	Coolwater piscivores	0.17	0.8	1.7	0.9
	Warmwater non-piscivores	0.17	5.6	13.5	7.9
	Warmwater piscivores	0.17	3.7	9.1	5.4
Spawning	Coldwater non-piscivores	0.17	12.7	27.2	14.5
	Coldwater piscivores	0.17	26	28.8	2.8
	Coolwater non-piscivores	0.17	4.1	12.7	8.6
	Coolwater piscivores	0.17	1.1	0.8	-0.3
	Warmwater non-piscivores	0.17	5	13.5	8.5
	Warmwater piscivores	0.17	12.7	3.4	-9.3
YOY	Coldwater non-piscivores	0.17	5.1	11.1	6
	Coldwater piscivores	0.17	0	1.8	1.8
	Coolwater non-piscivores	0.17	3.6	0.9	-2.7
	Coolwater piscivores	0.17	0	0	0
	Warmwater non-piscivores	0.17	0.1	0.7	0.6
	Warmwater piscivores	0.17	8.7	7.4	-1.3
Weighted Sum					
Adult		0.33	3.3	7	3.7
Spawning		0.33	10.3	14.4	4.1
YOY		0.33	2.9	3.6	0.7
Over All Sum			5.5	8.3	2.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	36	0	2.1	0	-2.1
MODD	19	19	1.1	2	0.9
MODI	-	-	-	-	-
COMM	40.6	40.6	2.3	6.3	4
COMC	-	-	-	-	-
TOTAL			5.5	8.3	2.8

Case 19. Concrete Retaining Wall, Lower Nottawasaga River, Wasaga Beach

Receive Date: 2000/04/27
Project Location: Lower reach of Nottawasaga River (lake influenced), Burlington District

Project Activity
Proposal: Stabilize eroding river bank with concrete block revetment.
Size of Work Area: 42m^2.
Description of Work: Stabilization of 18m section of shoreline, area lost 42m^2. Wall constructed using four rows to height of 3.7m above substrate in river. All submerged portions of wall modified through compensation measures, and not directly related to structure.
Material Used: Concrete blocks, size unspecified.

Pre Condition
Erosive shoreline, substrate primarily sand. Natural vegetation and instream cover are not common. Water depth 0-1m. Fish species include smallmouth bass, northern pike, and river is used as migratory corridor by rainbow trout and chinook salmon.

Compensation
Proposal: Creation of three indented/backwater areas with installation of cobble revetment along toe of revetment. Installation of root wads and bundles of live willow cuttings in cobble toe within three indented areas. Tree planting along top of wall.
Size of Compensation Area: 22.8m^2.
Description of Work: Three indented areas with areas of 1.6m^2 in each, to be formed within base of wall with at least three root wads anchored in the cobble revetment within reach indented area. Total of 10 brush bundles to be installed into cobble in each of three areas, with each bundle 0.3m apart. At least 13 native trees to be planted atop wall.
Material Used: Clean cobble stone (0.17-0.25cm diameter). Willow cuttings, each bundle 5-10cm in diameter.

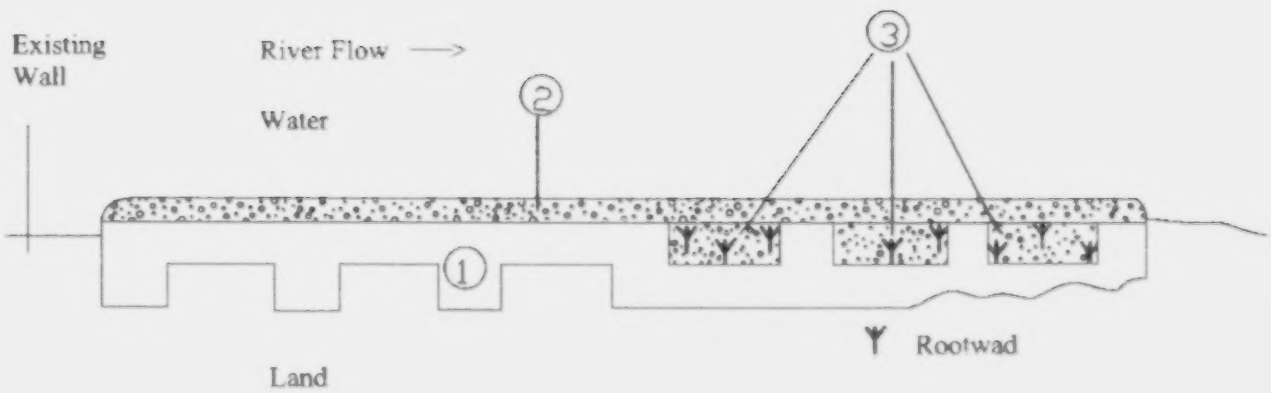
HAAT Analysis
Assumptions: Assigned values to vegetated riparian in the pre-development scenario, and riparian bundles as providing a degree of cover habitat in analysis.
Results:

- Overall project resulted in a loss of fish habitat however net change most strongly affected by the effect of changing substrate composition to rock.
- No fish habitat type experienced a gain, and largest net change was for cool water and warm water non-piscivorous fish species.
- Life stage most strongly affected was YOY.

Case 19. Concrete Block Retaining Wall, Lower Nottawasaga River, Wasaga Beach

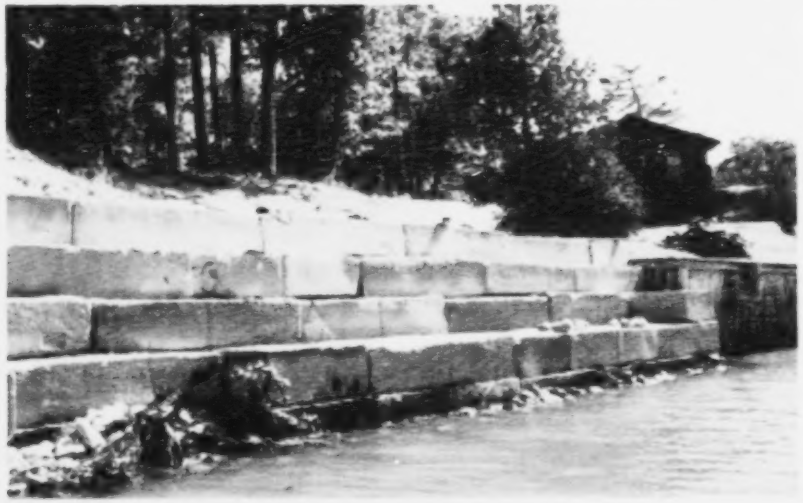
Expected Scenario

Pre-Construction phase photograph not available

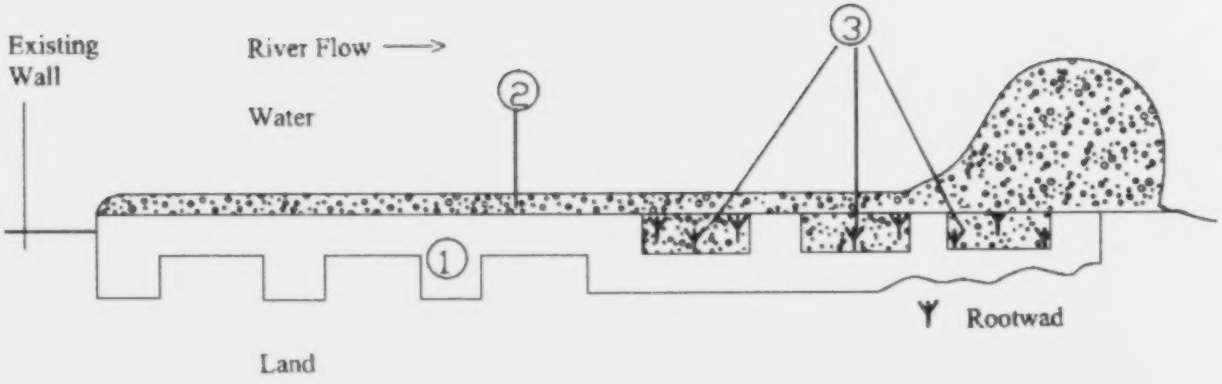


Case 19. Concrete Block Retaining Wall, Lower Nottawasaga River, Wasaga Beach (Actual Scenario)

Pre-Construction phase photograph not available



Post-Construction Phase



Case 19 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	42	LOSS		0-1	100% sand	10% emergent 10% submergent 80% no cover	1							infilling
2	18	COMM		0-1	100% sand	10% emergent 10% submergent 80% no cover	2	18	COMM		0-1	100% cobble	no cover	rip rap toe
3	4.8	COMM		0-1	100% sand	10% emergent 10% submergent 80% no cover	3	4.8	COMM		0-1	100% cobble	25% submergent 25% emergent 50% no cover	addition of dogwood bundles

Case 19 (cont'd)

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m^2)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	47.3	LOSS		0-1	100% sand	10% emergent 10% submergent 80% no cover	1							infilling
2	28	COMM		0-1	100% sand	10% emergent 10% submergent 80% no cover	2	28	COMM		0-1	100% cobble	no cover	rip rap toe
3	4.8	COMM		0-1	100% sand	10% emergent 10% submergent 80% no cover	3	4.8	COMM		0-1	100% cobble	25% submergent 25% emergent 50% no cover	addition of dogwood bundles

Case 19 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	42	LOSS		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	10	80	100
2	18	COMM		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	10	80	100
3	4.8	COMM		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	10	80	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	18	COMM		100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
3	4.8	COMM		100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	25	25	50	100

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	47.3	LOSS		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	10	80	100
2	28	COMM		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	10	80	100
3	4.8	COMM		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	10	80	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	28	COMM		100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
3	4.8	COMM		100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	25	25	50	100

Case 19 (cont'd)
Expected

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5	0.3	-4.7
	Coldwater piscivores	0.17	1.6	0	-1.6
	Coolwater non-piscivores	0.17	56.8	6.7	-50.1
	Coolwater piscivores	0.17	18.9	0.9	-18
	Warmwater non-piscivores	0.17	42.6	5.1	-37.5
	Warmwater piscivores	0.17	43.2	2.9	-40.3
Spawning	Coldwater non-piscivores	0.17	44.9	10.1	-34.8
	Coldwater piscivores	0.17	22	5.5	-16.5
	Coolwater non-piscivores	0.17	48.9	6.6	-42.3
	Coolwater piscivores	0.17	20.8	1.1	-19.7
	Warmwater non-piscivores	0.17	54.2	5.4	-48.8
	Warmwater piscivores	0.17	20.6	0.9	-19.7
YOY	Coldwater non-piscivores	0.17	32.9	2.9	-30
	Coldwater piscivores	0.17	44.2	0	-44.2
	Coolwater non-piscivores	0.17	58.6	0.7	-57.9
	Coolwater piscivores	0.17	10.4	0	-10.4
	Warmwater non-piscivores	0.17	26.3	0.2	-26.1
	Warmwater piscivores	0.17	25.4	2.4	-23
Weighted Sum					0
Adult		0.33	28	2.7	-25.3
Spawning		0.33	35.2	4.9	-30.3
YOY		0.33	33	1	-32
Over All Sum			32.1	2.9	-29.2

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	42	0	20.8	0	-20.8
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	22.8	22.8	11.3	2.9	-8.4
COMC	-	-	-	-	-
TOTAL			32.1	2.9	-29.2

Case 19 (cont'd)

Actual

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5.5	0	-5.5
	Coldwater piscivores	0.17	1.8	0	-1.8
	Coolwater non-piscivores	0.17	63.3	0.9	-62.4
	Coolwater piscivores	0.17	21.1	0.2	-20.9
	Warmwater non-piscivores	0.17	47.4	0.7	-46.7
	Warmwater piscivores	0.17	48.2	0.6	-47.6
Spawning	Coldwater non-piscivores	0.17	50	1.2	-48.8
	Coldwater piscivores	0.17	24.5	0.6	-23.9
	Coolwater non-piscivores	0.17	54.5	0.9	-53.6
	Coolwater piscivores	0.17	23.1	0.2	-22.9
	Warmwater non-piscivores	0.17	60.4	0.8	-59.6
	Warmwater piscivores	0.17	22.9	0.2	-22.7
YOY	Coldwater non-piscivores	0.17	36.7	0.4	-36.3
	Coldwater piscivores	0.17	49.3	0	-49.3
	Coolwater non-piscivores	0.17	65.3	0.1	-65.2
	Coolwater piscivores	0.17	11.5	0	-11.5
	Warmwater non-piscivores	0.17	29.3	0.1	-29.2
	Warmwater piscivores	0.17	28.3	0.3	-28
Weighted Sum					
Adult		0.33	31.2	0.4	-30.8
Spawning		0.33	39.2	0.7	-38.5
YOY		0.33	36.7	0.2	-36.5
OverAll Sum			35.7	0.4	-35.3

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	39.4	0	19.5	0	-19.5
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	32.8	4.8	16.2	0.4	-15.8
COMC	-	-	-	-	-
TOTAL			35.7	0.4	-35.3

Case 20. Shoreline Stabilization, Lower Nottawasaga River, Wasaga Beach

Receive Date: 1998/07/02
Project Location: Lower Nottawasaga River, Burlington District

Project Activity
Proposal: Stabilization of shoreline with 2.0m high vertical concrete block wall with boat launch access in mid portion of wall.
Size of Work Area: 30.4m^2.
Description of Work: Structure resulting in the loss of 20m^2 of fish habitat, and within 0-2m depth zone as per high water line. Boat launch to be capped in concrete, within 0-2m depth zone.
Material Used: Concrete slabs, each 1.8m long x 0.75m high.

Pre Condition
Sloped shoreline, substrate sand with scoured rock in open areas and aquatic plants in backwater areas. Waterbody provides cold, cool and warm water permanent and transient habitat for fish.

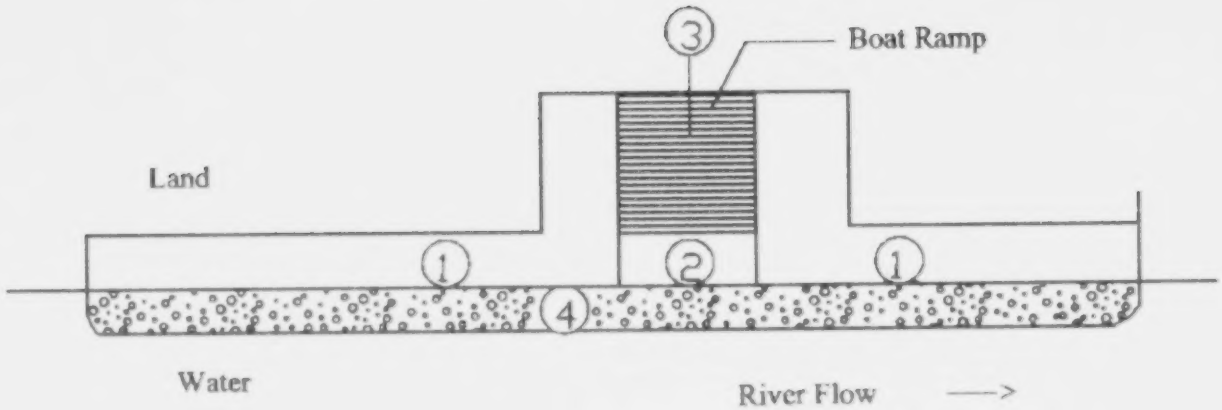
Compensation
Proposal: Rock rubble toe to diversify habitat conditions.
Size of Compensation Area: 16m^2.
Description of Work: Placement of rounded river run rock along length of toe.
Material Used: 0.16m-0.20m diameter river run stone.

HAAT Analysis
Assumptions: Area of infill in Authorization is not consistent with area of infill from MNR work permit application, however used DFO area of infill for calculations. Assigned cover parameter for vegetated shoreline in pre-development scenario, and substrate composition based on rock size requirement.
Results:

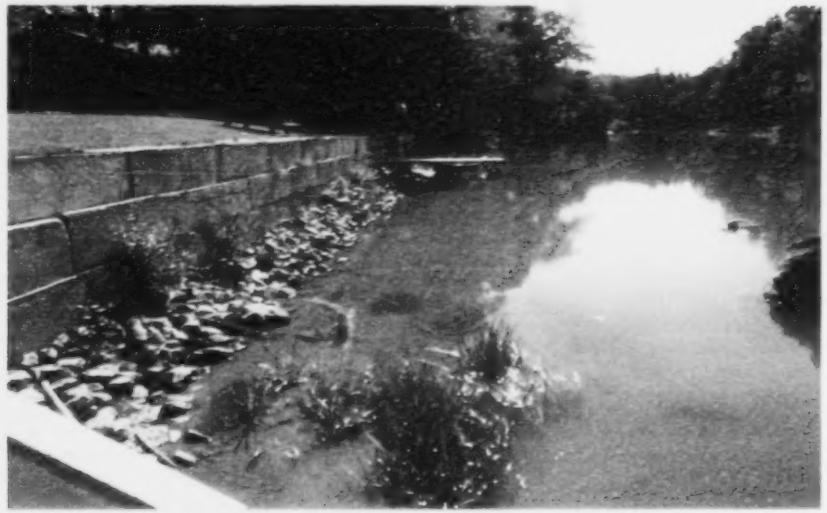
- Overall project resulted in net loss of fish habitat with all group ID's experiencing a negative net change.
- Similar to Case 19, cool water non-piscivorous YOY's most strongly impacted.

Expected Scenario

Pre-Construction phase photograph not available

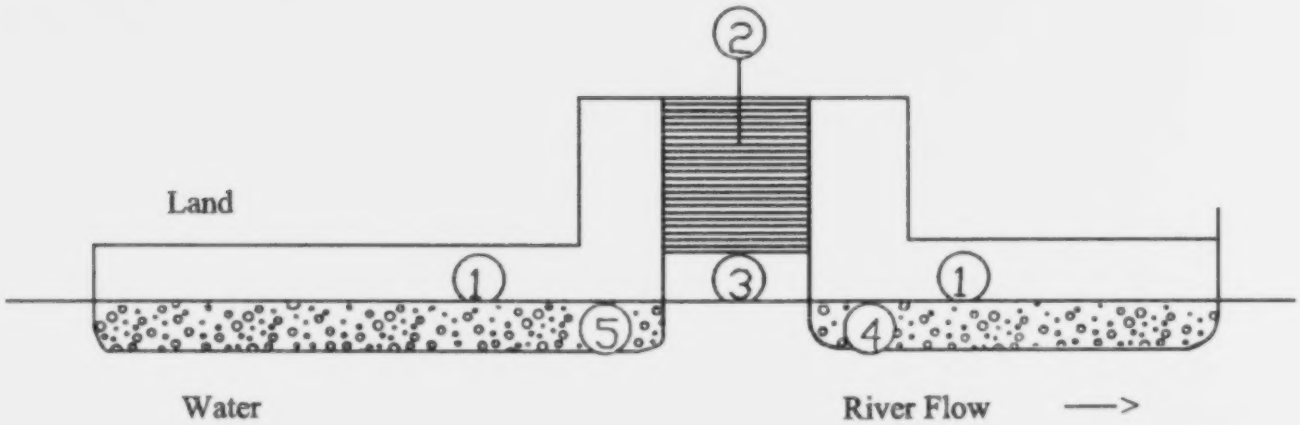


Case 20. Shoreline Stabilization, Lower Nottawasaga River, Wasaga Beach (Actual Scenario)



Post-Construction Phase

(Pre-Construction phase photograph not available)



Case 20 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	20	LOSS		0-1,1-2	sand	No Cover								infilling
2	5.2	MODD		1-2	sand	grass embankment =10% submergent, 90% no cover	2	5.2	MODD		1-2	concrete=bedrock	no cover	boat launch lower
3	5.2	MODD		0-1	sand	grass embankment =10% submergent, 90% no cover	3	5.2	MODD		0-1	concrete=bedrock	no cover	boat launch upper
4	16	COMM		1-2	sand	no cover	4	16	COMM		1-2	20% rubble 80% cobble	no cover	rock toe as per Auth.

Case 20 (cont'd)

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	28.4	LOSS		0-1,1-2	sand	no cover								infilling
2	4.9	MODD		1-2	sand	grass embankment =10% submergent, 90% no cover	2	4.9	MODD		1-2	sand	no cover	boat launch
3	4.9	MODD		0-1	sand	grass embankment =10% submergent, 90% no cover	3	4.9	MODD		0-1	sand	25% submergent 25% emergent 50% no cover	boat launch
4	17.8	COMM		1-2	sand	no cover	4	17.8	COMM		1-2	10% boulder 30% cobble 50% rubble 10% gravel	no cover	rock toe
5	17.8	COMM		1-2	sand	no cover	5	17.8	COMM		1-2	50% cobble 50% rubble		rock toe

Case 20 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	20	LOSS		50	50	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
2	5.2	MODD		0	100	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	0	90	100
3	5.2	MODD		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	0	90	100
4	16	COMM		0	100	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	5.2	MODD		0	100	0	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
3	5.2	MODD		100	0	0	0	0	100	100	0	0	0	0	0	0	0	0	100	0	0	100	100
4	16	COMM		0	100	0	0	0	100	0	0	80	20	0	0	0	0	0	100	0	0	100	100

Case 20 (cont'd)

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
	28.4	LOSS		50	50	0	0	0	100	0	0	0	0	0	100	0	0	0	100			100	100
	4.9	MODD		0	100	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	0	90	100
	4.9	MODD		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	10	0	90	100
	17.8	COMM		0	100	0	0	0	100						100				100	0	0	100	100
	17.8	COMM		0	100	0	0	0	100						100				100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	4.9	MODD		0	100	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
3	4.9	MODD		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
4	17.8	COMM			100				100	0	10	30	50	10	0	0	0	0	100	0	0	100	100
5	17.8	COMM			100				100	0	0	50	50	0	0	0	0	0	100	0	0	100	100

Case 20 (cont'd)
Expected

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	3.8	0.6	-3.2
	Coldwater piscivores	0.17	1.4	0.1	-1.3
	Coolwater non-piscivores	0.17	42.5	6.4	-36.1
	Coolwater piscivores	0.17	7.5	0.7	-6.8
	Warmwater non-piscivores	0.17	27.8	4.8	-23
	Warmwater piscivores	0.17	30.3	3	-27.3
Spawning	Coldwater non-piscivores	0.17	23.4	5.1	-18.3
	Coldwater piscivores	0.17	19.3	7.2	-12.1
	Coolwater non-piscivores	0.17	18.7	1.6	-17.1
	Coolwater piscivores	0.17	6.8	1	-5.8
	Warmwater non-piscivores	0.17	18.1	1.5	-16.6
	Warmwater piscivores	0.17	8.2	3.1	-5.1
YOY	Coldwater non-piscivores	0.17	30.3	2.3	-28
	Coldwater piscivores	0.17	40.4	3	-37.4
	Coolwater non-piscivores	0.17	45.5	1.5	-44
	Coolwater piscivores	0.17	10.7	0	-10.7
	Warmwater non-piscivores	0.17	13.2	0.4	-12.8
	Warmwater piscivores	0.17	16.7	2.9	-13.8
Weighted Sum					0
Adult		0.33	18.9	2.6	-16.3
Spawning		0.33	15.8	3.2	-12.6
YOY		0.33	26.1	1.7	-24.4
OverAll Sum			20.3	2.5	-17.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	20	0	9	0	-9
MODD	10.4	10.4	4.8	0.3	-5.1
MODI	-	-	-	-	-
COMM	16	16	6.5	2.2	-8.7
COMC	-	-	-	-	-
TOTAL			32.1	2.9	-22.8

Case 20 (cont'd)
Actual

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	6	2.3	-3.7
	Coldwater piscivores	0.17	2.3	0.7	-1.6
	Coolwater non-piscivores	0.17	67.7	26.2	-41.5
	Coolwater piscivores	0.17	11.3	3.3	-8
	Warmwater non-piscivores	0.17	43.9	19.5	-24.4
	Warmwater piscivores	0.17	47.9	16.9	-31
Spawning	Coldwater non-piscivores	0.17	35.4	18	-17.4
	Coldwater piscivores	0.17	30.9	24.8	-6.1
	Coolwater non-piscivores	0.17	26.9	9	-17.9
	Coolwater piscivores	0.17	10.2	3.7	-6.5
	Warmwater non-piscivores	0.17	25.1	8.5	-16.6
	Warmwater piscivores	0.17	12.6	6.9	-5.7
YOY	Coldwater non-piscivores	0.17	49	12.1	-36.9
	Coldwater piscivores	0.17	65.1	21.8	-43.3
	Coolwater non-piscivores	0.17	72.7	14.3	-58.4
	Coolwater piscivores	0.17	17.5	2.3	-15.2
	Warmwater non-piscivores	0.17	20.5	4.6	-15.9
	Warmwater piscivores	0.17	26.1	8.9	-17.2
Weighted Sum					
Adult		0.33	29.8	11.5	-18.3
Spawning		0.33	23.5	11.8	-11.7
YOY		0.33	41.8	10.7	-31.1
Over All Sum			31.7	11.3	-20.4

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	28.4	0	12.7	0	-12.7
MODD	9.8	9.8	4.5	4.4	-0.1
MODI					
COMM	35.6	35.6	14.5	6.9	-7.6
COMC					
TOTAL			31.7	11.3	-20.4

Case 21. Retaining Wall, Lower Nottawasaga River, Wasaga Beach

Receive Date: 1999/02/22
Project Location: Lower Nottawasaga River, Burlington District

Project Activity
Proposal: Installation of sheet pile retaining wall to stabilize shoreline.
Size of Work Area: 15m^2.
Description of Work: Sheet pile wall along 14m of shoreline combined with rock toe.
Material Used: Sheet piling.

Pre Condition
Substrate comprised of predominantly sand with river washed stone. Aquatic vegetation present, but sparse. Habitat in lower reach of river functions as a nursery area for juvenile fish. Fish species comprised of cold, cool and warm water fish species. Neighbouring shoreline hardened.

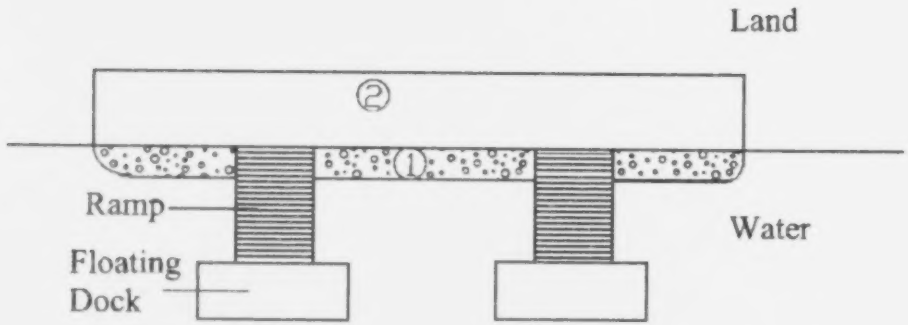
Compensation
Proposal: Rock placement along base of steel wall to provide cover and habitat diversity.
Size of Compensation Area: 15m^2.
Description of Work: Placement of rock rubble extending along toe of wall, at a width of 1m from wall into watercourse.
Material Used: Rock rubble toe comprised of 0.1m to 0.45m diameter stone.

HAAT Analysis
Assumptions: Based upon dimensions of structure, area of infill is greater than that stated in Authorization but used infill from Authorization in calculations.
Results:

- Overall project resulted in net loss of fish habitat.
- As in previous cases, habitat for YOY affected more than adults or spawners.
- Cool water YOY non-piscivores, and cold water YOY piscivores most strongly affected.

Case 21. Retaining Wall, Lower Nottawasaga River, Wasaga Beach (Expected Scenario)

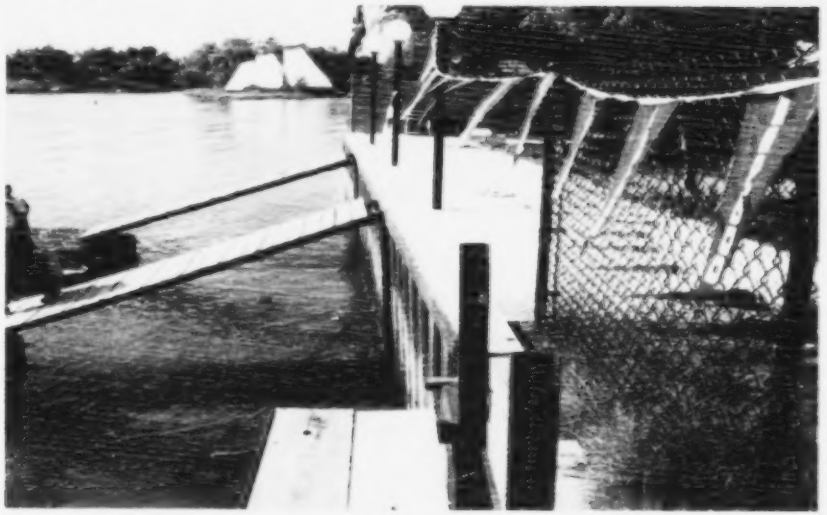
Pre- Construction phase photographs not available



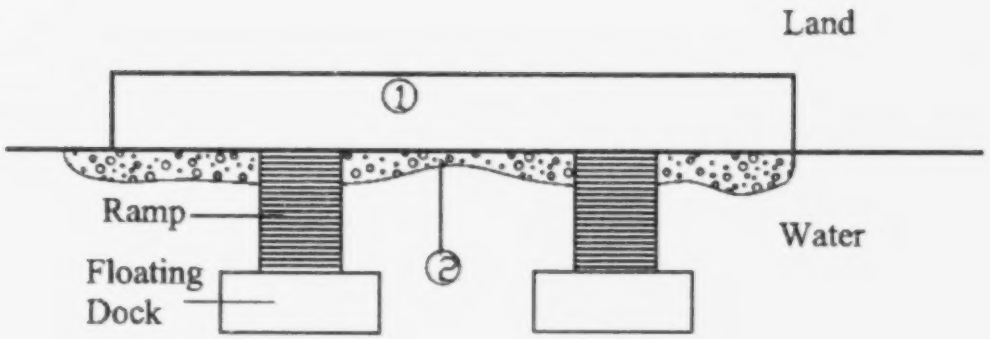
Case 21. Retaining Wall, Lower Nottawasaga River, Wasga Beach

Actual Scenario

Pre-Construction phase photographs not available



Post-Construction Phase



Case 21 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	15	LOSS		0-1	100% sand	no cover								infilling
2	15	COMM		0-1	100% sand	no cover	2	15.5	COMM		0-1	30% rubble 40% cobble 30% boulder	no cover	rock toe

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	14.1	LOSS		0-1	100% sand	no cover								infilling
2	15.5	COMM		0-1	100% sand	no cover	2	15.5	COMM		0-1	30% boulder 20% rubble 10% gravel 40% sand	no cover	rock toe

Case 21 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	15	LOSS		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
2	15	COMM		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	15 .5	COMM		100	0	0	0	0	100	0	30	40	30	0	100	0	0	0	100	0	0	100	100

Case 21 (cont'd)

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	14.1	LOSS		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
2	15.5	COMM		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	15.5	COMM		100	0	0	0	0	100	0	30	0	20	10	40	0	0	0	100	0	0	100	100

Case 21 (cont'd)
Expected

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	2.4	0.5	-1.9
	Coldwater piscivores	0.17	0.9	0.1	-0.8
	Coolwater non-piscivores	0.17	27.5	5.9	-21.6
	Coolwater piscivores	0.17	4.3	0.7	-3.6
	Warmwater non-piscivores	0.17	17.7	4.3	-13.4
	Warmwater piscivores	0.17	19.3	3.3	-16
Spawning	Coldwater non-piscivores	0.17	24.3	8.3	-16
	Coldwater piscivores	0.17	12.7	6.7	-6
	Coolwater non-piscivores	0.17	24	6.1	-17.9
	Coolwater piscivores	0.17	6.8	0.8	-6
	Warmwater non-piscivores	0.17	25.9	3.8	-22.1
	Warmwater piscivores	0.17	4.8	1.5	-3.3
YOY	Coldwater non-piscivores	0.17	16.3	2.1	-14.2
	Coldwater piscivores	0.17	25.3	2.1	-23.2
	Coolwater non-piscivores	0.17	28.4	1.1	-27.3
	Coolwater piscivores	0.17	4.4	0	-4.4
	Warmwater non-piscivores	0.17	8.1	0.5	-7.6
	Warmwater piscivores	0.17	10.4	2.2	-8.2
Weighted Sum					0
Adult		0.33	12	2.5	-9.5
Spawning		0.33	16.4	4.5	-11.9
YOY		0.33	15.5	1.3	-14.2
OverAll Sum			14.7	2.8	-11.9

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	15	0	7.3	0	-7.3
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	15	15.5	7.3	2.8	-4.5
COMC	-	-	-	-	
TOTAL			14.6	2.8	-11.8

Case 21 (cont'd)

Actual

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	2.4	0.9	-1.5
	Coldwater piscivores	0.17	0.9	0.3	-0.6
	Coolwater non-piscivores	0.17	27.1	10.2	-16.9
	Coolwater piscivores	0.17	4.2	1.4	-2.8
	Warmwater non-piscivores	0.17	17.4	6.8	-10.6
	Warmwater piscivores	0.17	19.1	6.8	12.3
Spawning	Coldwater non-piscivores	0.17	24	10.8	-13.2
	Coldwater piscivores	0.17	12.6	8	-4.6
	Coolwater non-piscivores	0.17	23.7	9.5	-14.2
	Coolwater piscivores	0.17	6.7	1.9	-4.8
	Warmwater non-piscivores	0.17	25.5	8.5	-17
	Warmwater piscivores	0.17	4.8	2.3	-2.5
YOY	Coldwater non-piscivores	0.17	16.1	5	-11.1
	Coldwater piscivores	0.17	25	8.1	-16.9
	Coolwater non-piscivores	0.17	28	7.5	-20.5
	Coolwater piscivores	0.17	4.4	1	-3.4
	Warmwater non-piscivores	0.17	8	2.2	-5.8
	Warmwater piscivores	0.17	10.2	3.5	-6.7
Weighted Sum					
Adult		0.33	11.9	4.4	-7.5
Spawning		0.33	16.2	6.8	-9.4
YOY		0.33	15.3	4.5	-10.8
Over All Sum					

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	14.1	0	6.9	0	-6.9
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	15.5	15.5	7.6	5.3	-2.3
COMC	-	-	-	-	-
TOTAL			14.5	5.3	-9.2

Case 22. Cedar Post Retaining Wall, Lower Nottawasga River, Wasaga Beach

Receive Date: 1998/05/26
Project Location: Lower Nottawasaga River, Burlington District

Project Activity
Proposal: Construction of cedar post retaining wall to stabilize erosive shoreline.
Size of Work Area: 54m^2.
Description of Work: Construction of 15m long, 3.6m wide retaining wall resulting in infilling of 54m^2. Structure within 0-1 depth zone.
Material Used: Cedar posts.

Pre Condition
Eroding steep shoreline, with sandy substrate in watercourse that deepens rapidly due to boating activity and location along outer bend of lower Nottawasaga River. Site provides migratory route for rainbow trout, chinook salmon, walleye and suckers. Resident species comprised of northern pike, smallmouth bass, channel catfish and common carp.

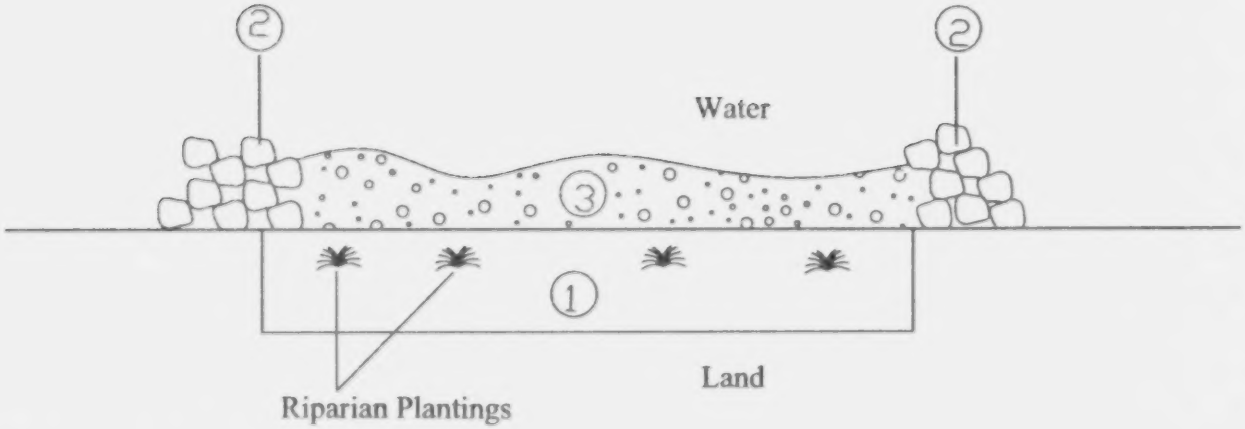
Compensation:
Proposal: Rock placement including rubble toe, and boulder clusters, as well as tree planting along top of wall.
Size of Compensation Area: 18m^2.
Description of Work: Rock rubble toe to be placed along length of wall, 1m wide, and two boulder clusters comprised of four boulders in each. Native trees to be planted atop wall to provide shade cover. Rock structures within 0-2m depth zone due to rapid sloping nearshore zone.
Material Used: Rock rubble comprised of 0.1m to 0.45m diameter stone, and boulders each 0.5-1.0m diameter combined with smaller substrate within structure.

HAAT Analysis:
Assumptions: Assigned riparian plantings a % cover designation, and substrate composition for compensation requirements based upon rock size requirement in Authorization.
Results:
- Overall project resulted in a loss of fish habitat.
- As in previous cases, habitat for YOY affected more than adults or spawners.
- Cool water YOY non-piscivores, and adult cold water non-piscivores most strongly affected.

Case 22. Cedar Post Retaining Wall, Lower Nottawasaga River, Wasaga Beach

Expected Scenario

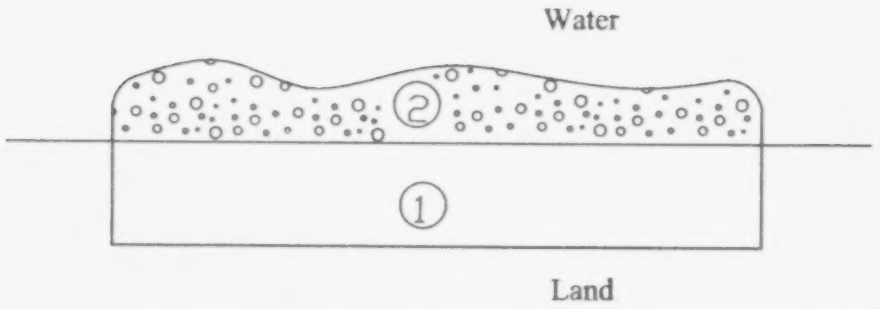
Pre--Construction phase photograph not available



Case 22. Cedar Post Retaining Wall, Lower Nottawasaga River, Wasaga Beach

Actual Scenario

Pre- and Post-Construction phase photographs not available



Case 22 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	54	LOSS		0-1	sand	no cover								as per Auth.
2	6	COMM		0-2	sand	no cover	2	6	COMM		0-2	80% boulder 10% cobble 10% rubble	riparian plantings = 5% emergent 95% no cover	boulder clusters
3	12	COMM		0-2	sand	no cover	3	12	COMM		0-2	30% boulder 40% cobble 30% rubble	riparian plantings = 5% emergent 95% no cover	rubble toe

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	47.7	LOSS		0-1	sand	no cover								steel retaining wall
2	15.9	COMM		0-2	sand	no cover	2	15.9	COMM		0-2	30% boulder 40% cobble 30% sand	no cover	rock rubble toe

Case 22 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	54	LOSS		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
2	6	COMM		50	50	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
3	12	COMM		50	50	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	6	COMM		50	50	0	0	0	100	0	80	10	10	0	0	0	0	0	100	0	5	95	100
3	12	COMM		50	50	0	0	0	100	0	30	40	30	0	0	0	0	0	100	0	5	95	100

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	47.7	LOSS		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
2	15.9	COMM		50	50	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	15.9	COMM		50	50	0	0	0	100	0	30	40	0	0	30	0	0	0	100	0	0	100	100

Case 22 (cont'd)
Expected

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5.9	0.5	-5.4
	Coldwater piscivores	0.17	2.2	0.1	-2.1
	Coolwater non-piscivores	0.17	6.6	6.1	-59.9
	Coolwater piscivores	0.17	10.2	0.8	-9.4
	Warmwater non-piscivores	0.17	42.4	4.2	-38.2
	Warmwater piscivores	0.17	46.4	3.5	-42.9
Spawning	Coldwater non-piscivores	0.17	54.5	6.9	-47.6
	Coldwater piscivores	0.17	30.6	6.8	-23.8
	Coolwater non-piscivores	0.17	52.4	3.8	-48.6
	Coolwater piscivores	0.17	15.3	0.9	-14.4
	Warmwater non-piscivores	0.17	55.8	2.5	-53.3
	Warmwater piscivores	0.17	11.6	1.6	-10
YOY	Coldwater non-piscivores	0.17	40.7	2.3	-38.4
	Coldwater piscivores	0.17	61.4	2.5	-58.9
	Coolwater non-piscivores	0.17	68.6	1	-67.6
	Coolwater piscivores	0.17	11.7	0	-11.7
	Warmwater non-piscivores	0.17	19.3	0.4	-18.9
	Warmwater piscivores	0.17	24.9	2.3	-22.6
Weighted Sum					
Adult		0.33	28.9	2.5	-26.4
Spawning		0.33	36.7	3.7	-33
YOY		0.33	37.8	1.4	-36.4
Over All Sum			34.4	2.6	-31.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	54	0	26.4	0	-26.4
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	18	18	8.1	2.6	-5.5
COMC	-	-	-	-	-
TOTAL			34.5	2.6	-31.9

Case 22 (cont'd)

Actual

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5.2	0.6	-4.6
	Coldwater piscivores	0.17	2	0.1	-1.9
	Coolwater non-piscivores	0.17	58.3	7.6	-50.7
	Coolwater piscivores	0.17	9	1.1	-7.9
	Warmwater non-piscivores	0.17	37.5	4.9	-32.6
	Warmwater piscivores	0.17	41	4.5	-36.5
Spawning	Coldwater non-piscivores	0.17	48.1	7	-41.1
	Coldwater piscivores	0.17	27	5	-22
	Coolwater non-piscivores	0.17	46.3	4.3	-42
	Coolwater piscivores	0.17	13.5	1.3	-12.2
	Warmwater non-piscivores	0.17	49.3	3.9	-45.4
	Warmwater piscivores	0.17	10.2	1.2	-9
YOY	Coldwater non-piscivores	0.17	35.9	4.4	-31.5
	Coldwater piscivores	0.17	54.2	4.7	-49.5
	Coolwater non-piscivores	0.17	60.6	4.9	-55.7
	Coolwater piscivores	0.17	10.3	1	-9.3
	Warmwater non-piscivores	0.17	17.1	1.3	-15.8
	Warmwater piscivores	0.17	22	3	-19
Weighted Sum					
Adult		0.33	25.5	3.1	-22.4
Spawning		0.33	32.4	3.8	-28.6
YOY		0.33	33.4	3.2	-30.2
OverAll Sum			30.4	3.4	-27

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	47.7	0	23.3	0	-23.3
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	15.9	15.9	7.1	3.4	-3.7
COMC	-	-	-	-	-
TOTAL			30.4	3.4	-27

Case 23. Construction of Breakwall, Georgian Bay, Collingwood

Receive Date: 98/06/24
Project Location: Georgian Bay, Lake Huron, Burlington District

Project Activity
Proposal: Undulating armourstone breakwall along length of property shoreline and waterfront access, and installation of three crib docks.
Size of Work Area: 40.2m^2.
Description of Work: Vertical breakwall within 0-1 depth zone, area lost 27m^2.
Material Used: Armourstone 1.52m wide and three crib docks; two of which sized 0.92m x 3.08m and one 2.46m x 3.08m.

Pre Condition
Exposed shoreline, open shore dominated by bedrock and shale substrate with extensive areas less than 2m deep. Habitat utilized by both adult and juvenile smallmouth bass and juvenile salmonids (rainbow trout, lake trout, brown trout, chinook salmon) as early rearing habitat.

Indirect Effects
Wave action north westerly resulting in protected thermal refuge for fish adjacent to rock structures placed as compensation for HADD, totalling 51m^2.

Compensation
Proposal: Substrate enhancement through placement of consolidated rock reef structure.
Size of Compensation Area: 47m^2.
Description of Work: Placement of three protruding rock structures and a gravel pad to provide increased substrate diversity, spawning opportunities and invertebrate production.
Material Used: Rock habitat structure A: cobble/rubble/gravel, B: gravel, C: rubble, and D: boulder/cobble/rubble/gravel.

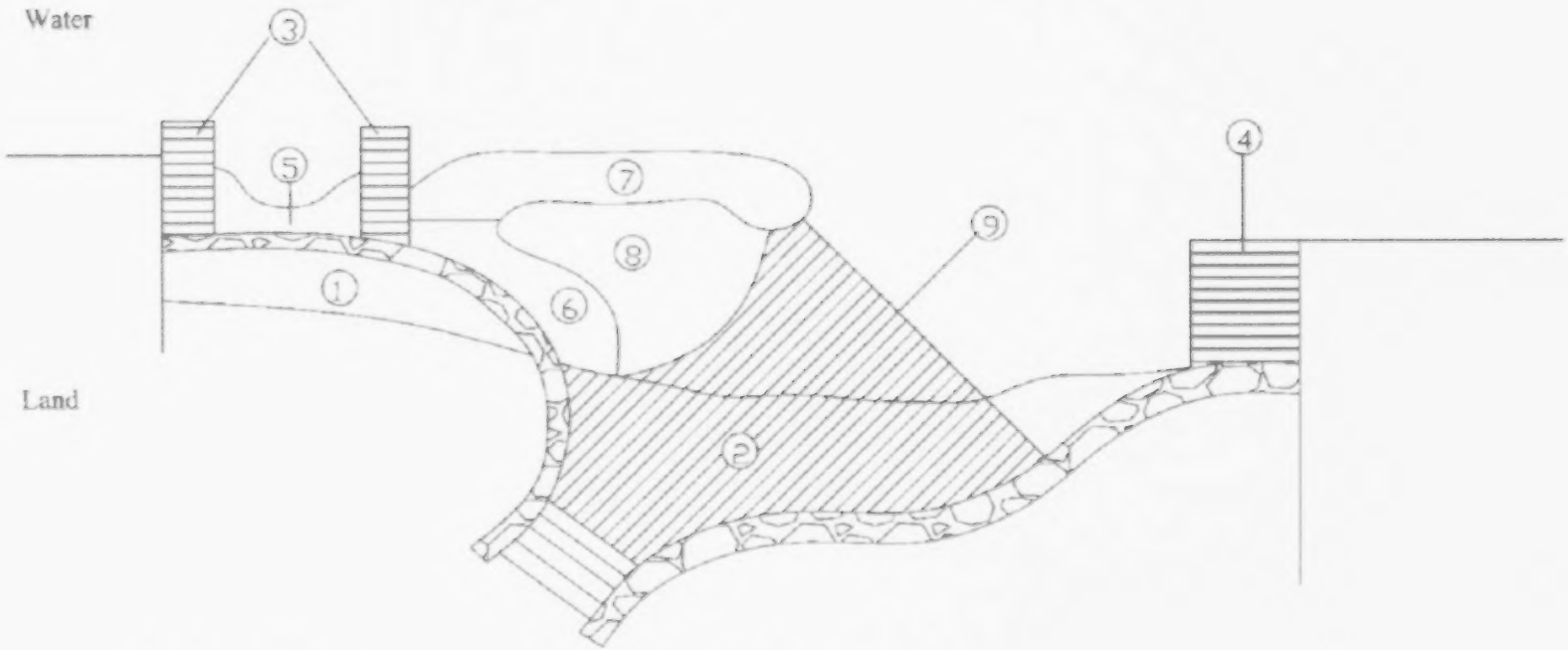
HAAT Analysis
Assumptions: Classification of substrate generated from size descriptors in Authorization, assigned bedrock/shale substrate as bedrock and rubble, made assumption that rock substrate in area of MODI would change to smaller size stone.
Results:

- Overall project resulted in net gain of fish habitat.
- Highest gain observed in adult and spawning cool water non-piscivores with highest general trend in spawners with adult and YOY experiencing similar net gain.
- Cool water piscivores experience the least degree of gain.

Case 23. Construction of Breakwall, Collingwood, Georgian Bay

Expected Scenario

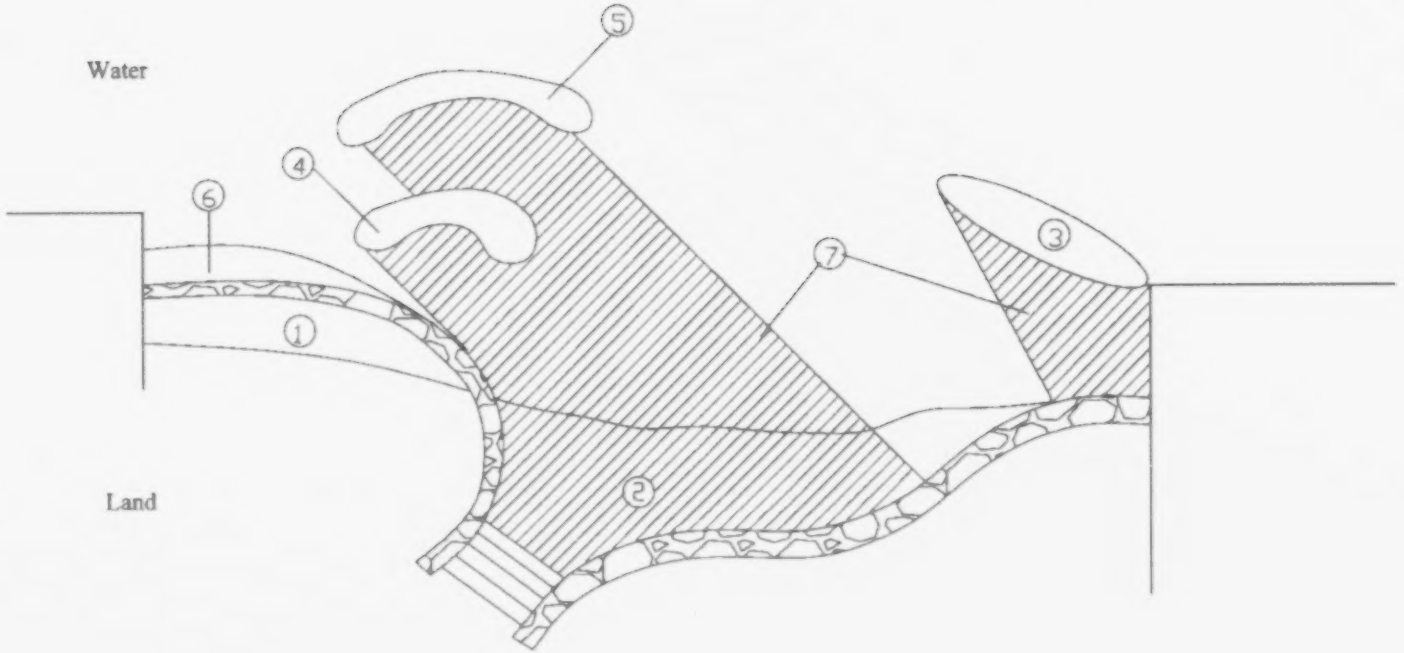
Pre-Construction phase photograph not available



Case 23. Construction of Breakwall, Collingwood, Georgian Bay (Actual Scenario)

Pre-Construction phase photograph not available

Post-Construction Phase



Case 23 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	27	LOSS	1	0-1	Shale = 50% rubble 50% bedrock	no cover	1							
2							2	40	COMC	1	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	have no info on what there previously
3	7.6	MODD	0.64	0-1			3	7.6	MODD	0.64	0-1	Crib dock = 30% bedrock 30% boulder 20% cobble 20% rubble	no cover	two crib docks, windward
4	5.6	MODD	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	4	5.6	MODD	0.64	0-1	Crib dock = 30% bedrock 30% boulder 20% cobble 20% rubble	no cover	1 crib dock - windward
5	3	COMM	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	5	3	COMM	0.64	0-1	25% boulder 25% cobble 25% rubble 25% gravel	no cover	rock area D - windward
6	9	COMM	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	6	9	COMM	1	0-1	30% gravel 35% rubble 35% cobble	no cover	rock Area A
7a	7.5	COMM	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	7a	7.5	COMM	0.64	0-1	100% rubble	no cover	rock Area C - windward
7b	7.5	COMM	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	7b	7.5	COMM	1	0-1	100% rubble	no cover	rock Area C - leeward
8	20	COMM	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	8	20	COMM	1	0-1	100% gravel	no cover	rock Area B
9	51	MODI	0.64	0-1	Shale = 50% rubble 50% bedrock	no cover	9	51	MODI	1	0-1	40% gravel 50% rubble 10% cobble	no cover	indirect effect from fetch

Case 23 (cont'd)

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	27	LOSS	1	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover								
							2	7.6	COMC	1	0-1	20% rubble 40% gravel 30% sand 10% silt	no cover	created habitat
3	16	MODD	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	3	16	MODD	0.64	0-1	25% boulder 45% cobble 20% rubble 10% gravel	no cover	rock groyne
4a	5.3	MODD	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	4a	5.3	MODD	0.64	0-1	70% boulder 20% cobble 10% rubble	no cover	rock groyne - windward
4b	5.3	MODD	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	4b	5.3	MODD	1	0-1	70% boulder 20% cobble 10% rubble	no cover	rock groyne - leeward
5a	4.4	MODD	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	5a	4.4	MODD	0.64	0-1	10% boulder 55% cobble 30% rubble 5% gravel	no cover	rock groyne windward
5b	4.4	MODD	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	5b	4.4	MODD	1	0-1	10% boulder 55% cobble 30% rubble 5% gravel	no cover	rock groyne leeward
6	0.8	MODD	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	6	0.8	MODD	0.64	0-1	10% boulder 25% cobble 40% rubble 25% gravel	no cover	rock toe - windward
7	40+23.6	MODI	0.64	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	7	72.2	MODI	1	0-1	30% rubble 35% gravel 30% sand 5% silt	no cover	area behind rock from

Case 23 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	27	LOSS	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
3	7.6	MODD	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
4	5.6	MODD	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
5	3	COMM	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
6	9	COMM	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
7a	7.5	COMM	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
7b	7.5	COMM	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
8	20	COMM	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100
9	51	MODI	0.64	100	0	0	0	0	100	50	0	0	50	0	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	40	COMC	1	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
3	7.6	MODD	0.64	100	0	0	0	0	100	30	30	20	20	0	0	0	0	0	100	0	0	100	100
4	5.6	MODD	0.64	100	0	0	0	0	100	30	30	20	20	0	0	0	0	0	100	0	0	100	100
5	3	COMM	0.64	100	0	0	0	0	100	0	25	25	25	25	0	0	0	0	100	0	0	100	100
6	9	COMM	1	100	0	0	0	0	100	0	0	35	35	30	0	0	0	0	100	0	0	100	100
7a	7.5	COMM	0.64	100	0	0	0	0	100	0	0	0	100	0	0	0	0	0	100	0	0	100	100
7b	7.5	COMM	1	100	0	0	0	0	100	0	0	0	100	0	0	0	0	0	100	0	0	100	100
8	20	COMM	1	100	0	0	0	0	100	0	0	0	0	100	0	0	0	0	100	0	0	100	100
9	51	MODI	1	100	0	0	0	0	100	0	0	10	50	40	0	0	0	0	100	0	0	100	100

Case 23 (cont'd)

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	27	LOSS	1	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
3	16	MODD	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
4a	5.3	MODD	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
4b	5.3	MODD	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
5a	4.4	MODD	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
5b	4.4	MODD	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
6	0.8	MODD	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100
7	72.2	MODI	0.64	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	7.6	COMC	1	100	0	0	0	0	100	0	0	0	20	40	30	10	0	0	100	0	0	100	100
3	16	MODD	0.64	100	0	0	0	0	100	0	25	45	20	10	0	0	0	0	100	0	0	100	100
4a	5.3	MODD	0.64	100	0	0	0	0	100	0	70	20	10	0	0	0	0	0	100	0	0	100	100
4b	5.3	MODD	1	100	0	0	0	0	100	0	70	20	10	0	0	0	0	0	100	0	0	100	100
5a	4.4	MODD	0.64	100	0	0	0	0	100	0	10	55	30	5	0	0	0	0	100	0	0	100	100
5b	4.4	MODD	1	100	0	0	0	0	100	0	10	55	30	5	0	0	0	0	100	0	0	100	100
6	0.8	MODD	0.64	100	0	0	0	0	100	0	10	25	40	25	0	0	0	0	100	0	0	100	100
7	72.2	MODI	1	100	0	0	0	0	100	0	0	0	30	35	30	5	0	0	100	0	0	100	100

Case 23 (cont'd)

Expected - Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5.5	9.9	4.4
	Coldwater piscivores	0.17	1.4	3.4	2
	Coolwater non-piscivores	0.17	43.1	108.9	65.8
	Coolwater piscivores	0.17	4.2	12.2	8
	Warmwater non-piscivores	0.17	34.8	81.3	46.5
	Warmwater piscivores	0.17	29.2	69.6	40.4
Spawning	Coldwater non-piscivores	0.17	47.9	113.6	65.7
	Coldwater piscivores	0.17	64.1	116.6	52.5
	Coolwater non-piscivores	0.17	53.7	115.9	62.2
	Coolwater piscivores	0.17	5.8	12.1	6.3
	Warmwater non-piscivores	0.17	29	96.4	67.4
	Warmwater piscivores	0.17	28.7	31.5	2.8
YOY	Coldwater non-piscivores	0.17	10.9	39.9	29
	Coldwater piscivores	0.17	31.8	90	58.2
	Coolwater non-piscivores	0.17	15.7	60.9	45.2
	Coolwater piscivores	0.17	0	3.7	3.7
	Warmwater non-piscivores	0.17	6.3	18.9	12.6
	Warmwater piscivores	0.17	18.5	26.7	8.2
Weighted Sum					
Adult		0.33	19.7	47.6	27.9
Spawning		0.33	38.2	81	42.8
YOY		0.33	13.9	40	26.1
Over All Sum			23.9	56.2	32.3

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	27	0	4.7	0	-4.7
MODD	13.2	13.2	2.3	1.7	-0.6
MODI	51	51	8.8	19	10.2
COMM	47	47	8.1	18.3	10.2
COMC	0	40	0	17.2	17.2
TOTAL			23.9	56.2	32.3

Case 23 (cont'd)
Expected - Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	5.5	9.9	4.4
	Coldwater piscivores	0.17	1.4	3.4	2
	Coolwater non-piscivores	0.17	43.1	108.9	65.8
	Coolwater piscivores	0.17	4.2	12.2	8
	Warmwater non-piscivores	0.17	34.8	81.3	46.5
	Warmwater piscivores	0.17	29.2	69.6	40.4
Spawning	Coldwater non-piscivores	0.17	47.9	113.6	65.7
	Coldwater piscivores	0.17	64.1	116.6	52.5
	Coolwater non-piscivores	0.17	53.7	115.9	62.2
	Coolwater piscivores	0.17	5.8	12.1	6.3
	Warmwater non-piscivores	0.17	29	96.4	67.4
	Warmwater piscivores	0.17	28.7	31.5	2.8
YOY	Coldwater non-piscivores	0.17	10.9	39.9	29
	Coldwater piscivores	0.17	31.8	90	58.2
	Coolwater non-piscivores	0.17	15.7	60.9	45.2
	Coolwater piscivores	0.17	0	3.7	3.7
	Warmwater non-piscivores	0.17	6.3	18.9	12.6
	Warmwater piscivores	0.17	18.5	26.7	8.2
Weighted Sum					
Adult		0.33	19.7	47.6	27.9
Spawning		0.33	38.2	81	42.8
YOY		0.33	13.9	40	26.1
Over All Sum			23.9	56.2	32.3

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	27	0	4.7	0	-4.7
MODD	13.2	13.2	2.3	1.7	-0.6
MODI	51	51	8.8	19	10.2
COMM	47	47	8.1	18.3	10.2
COMC	0	30	0	17.2	17.2
TOTAL			23.9	56.2	32.3

Case 23 (cont'd)
Expected - Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	3.5	9.5	6
	Coldwater piscivores	0.17	0.9	3.4	2.5
	Coolwater non-piscivores	0.17	27.6	105.5	77.9
	Coolwater piscivores	0.17	2.7	11.8	9.1
	Warmwater non-piscivores	0.17	22.3	78.7	56.4
	Warmwater piscivores	0.17	18.7	67.4	48.7
Spawning	Coldwater non-piscivores	0.17	30.6	109.3	78.7
	Coldwater piscivores	0.17	41	112.2	71.2
	Coolwater non-piscivores	0.17	34.3	112.1	77.8
	Coolwater piscivores	0.17	3.7	11.6	7.9
	Warmwater non-piscivores	0.17	18.5	94.1	75.6
	Warmwater piscivores	0.17	18.4	30.1	11.7
YOY	Coldwater non-piscivores	0.17	7	38.8	31.8
	Coldwater piscivores	0.17	20.4	87.9	67.5
	Coolwater non-piscivores	0.17	10	59.9	49.9
	Coolwater piscivores	0.17	0	3.7	3.7
	Warmwater non-piscivores	0.17	4	18.5	14.5
	Warmwater piscivores	0.17	11.8	25.5	13.7
Weighted Sum					
Adult		0.33	12.6	46	33.4
Spawning		0.33	24.4	78.2	53.8
YOY		0.33	8.9	39.1	30.2
Over All Sum			15.3	54.4	39.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	17.3	0	3	0	-3
MODD	8.4	8.4	1.5	1.1	-0.4
MODI	32.6	51	5.6	19	13.4
COMM	30.1	43.2	5.2	17.2	12
COMC	0	40	0	17.2	17.2
TOTAL			15.3	54.5	39.2

Case 23 (cont'd)
Actual - Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	10.2	7.1	-3.1
	Coldwater piscivores	0.17	3.8	2.5	-1.3
	Coolwater non-piscivores	0.17	110.2	79.2	-31
	Coolwater piscivores	0.17	14.2	10.2	-4
	Warmwater non-piscivores	0.17	79.4	56.9	-22.5
	Warmwater piscivores	0.17	75	52.1	-22.9
Spawning	Coldwater non-piscivores	0.17	106.6	82.8	-23.8
	Coldwater piscivores	0.17	99.6	73.8	-25.8
	Coolwater non-piscivores	0.17	110.9	79.3	-31.6
	Coolwater piscivores	0.17	16.8	11.7	-5.1
	Warmwater non-piscivores	0.17	100.7	69.2	-31.5
	Warmwater piscivores	0.17	27.9	19.7	-8.2
YOY	Coldwater non-piscivores	0.17	47.5	33.5	-14
	Coldwater piscivores	0.17	97.4	62.9	-34.5
	Coolwater non-piscivores	0.17	82	52.2	-29.8
	Coolwater piscivores	0.17	8.8	5.3	-3.5
	Warmwater non-piscivores	0.17	24.3	15.6	-8.7
	Warmwater piscivores	0.17	30.7	23	-7.7
Weighted Sum					0
Adult		0.33	48.8	34.6	-14.2
Spawning		0.33	77.1	56.1	-21
YOY		0.33	48.5	32.1	-16.4
Over All Sum			58.1	40.9	-17.2

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	27	0	11.6	0	-11.6
MODD	36.2	36.2	15.5	6.6	-8.9
MODI	72.2	72.2	31	31	0
COMM	-	-	-	-	-
COMC	0	7.6	0	3.3	3.3
TOTAL			58.1	40.9	-17.2

Case 23 (cont'd)

Actual - Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	7.2	6.8	-0.4
	Coldwater piscivores	0.17	2.7	2.4	-0.3
	Coolwater non-piscivores	0.17	78.5	75.4	-3.1
	Coolwater piscivores	0.17	10.1	9.7	-0.4
	Warmwater non-piscivores	0.17	56.5	54.1	-2.4
	Warmwater piscivores	0.17	53.4	50	-3.4
Spawning	Coldwater non-piscivores	0.17	75.9	77.4	1.5
	Coldwater piscivores	0.17	70.9	69.7	-1.2
	Coolwater non-piscivores	0.17	79	75.4	-3.6
	Coolwater piscivores	0.17	11.9	11.2	-0.7
	Warmwater non-piscivores	0.17	71.7	66.5	-5.2
	Warmwater piscivores	0.17	19.8	18.8	-1
YOY	Coldwater non-piscivores	0.17	33.8	32	-1.8
	Coldwater piscivores	0.17	69.3	61.3	-8
	Coolwater non-piscivores	0.17	58.4	51.2	-7.2
	Coolwater piscivores	0.17	6.3	5.3	-1
	Warmwater non-piscivores	0.17	17.3	15.2	-2.1
	Warmwater piscivores	0.17	21.8	21.7	-0.1
Weighted Sum					0
Adult		0.33	34.7	33.1	-1.6
Spawning		0.33	54.9	53.2	-1.7
YOY		0.33	34.5	31.1	-3.4
OverAll Sum			41.4	39.1	-2.3

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	27	0	11.6	0	-11.6
MODD	23.2	26.7	9.9	4.8	-5.1
MODI	46.2	72.2	19.8	31	11.2
COMM	-	-	-	-	-
COMC	0	7.6	0	3.3	3.3
TOTAL			41.3	39.1	-2.2

Case 24. Construction of Rock Groyne Extension Nottawasaga Bay, Georgian Bay

Receive Date: 2000/05/23
Project Location: Georgian Bay, Lake Huron, Burlington District

Project Activity
Proposal: Extension of existing rock groyne and dredging a boat channels to allow boat access to deeper water.
Size of Work Area: 527.5m^2.
Description of Work: Existing groyne to be extended by 12m with 2.5m opening to permit fish passage and water circulation. Two boat channels, 48m wide by 10m wide to be dredged to 1.5m depth adjacent to groyne, and disturbed area dredged to be lined with stone to stabilize clay substrate. Portion of extension above high water line is 3.1m^2, with portions underwater categorized into two areas of MODD divided into two areas to reflect leeward and windward conditions. Area dredged and MODI also segregated into leeward and windward categories.
Material Used: Groyne extension to be constructed using clean boulders and side slopes not exceeding 1:1 with width and length to remain the same as the existing groyne extending perpendicular from the shoreline. Substrate in dredged channel capped with cobble/rubble stone.

Pre Condition
Substrate comprised of cobble and rubble underlain by fine clay.

Indirect Effects
Fetch from northwest creating area on east side of groyne extension affected indirectly from rock structure. Area of MODI extends from groyne extension to beach on a ~45 degree angle extending across area of dredging. MODI is located leeward and in the post development scenario expected to make positive contribution to net change balance with a greater condition index than the pre-development scenario.

Compensation
Proposal: Opening to remain between existing groyne and extension, no greater than 1:1 side slopes and use of clean boulders to construct extension.
Size of Compensation Area: 9.6m^2
Description of Work: Opening in groyne to be created by placing boulders for extension approximately 2.5m from existing groyne.
Material Used: Clean boulders.

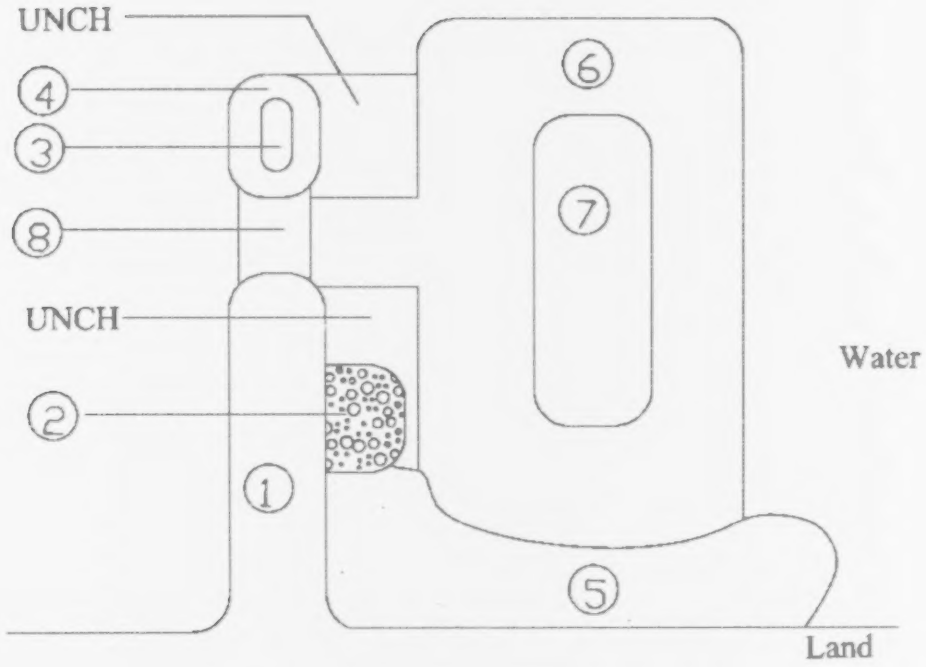
HAAT Analysis
Assumptions: Substrate composition in groyne extension considered anthropogenic substrate as described by C.K. Minns, (2001). Estimated side slopes on groyne to be at 1:1 to determine area MODD and LOSS. Considered existing groyen unchanged and not included in calculations.
Results:

- Overall project resulted in net gain of fish habitat.
- Largest gain in fish habitat for spawning and YOY cold water piscivores, with highest net positive effect upon adults minus net change for only two YOY groups; cool and warm water non-piscivores.

Case 24. Construction of Rock Groyne Extension, Nottawasaga Bay, Georgian Bay

Expected Scenario

Pre-Construction phase photographs not available

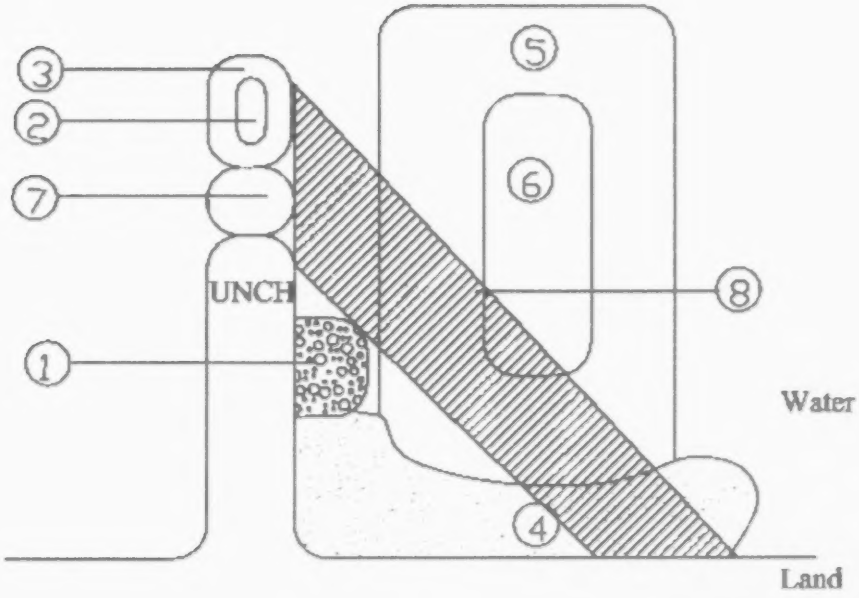


Case 24. Construction of Rock Groyne Extension, Nottawasaga Bay, Georgian Bay

Actual Scenario

Pre-Construction phase photographs not available

Post-Construction Phase



Case 24 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	3.1	LOSS	1	0-1	100% cobble	no cover								rock groyne above water level by 0.32m
2a	16.5	MODD	0.64	0-1	100% cobble	no cover	2a	16.5	MODD	1	0-1	65% bedrock 25% boulder 5% rubble 5% sand	no cover	rock groyne under water level, leeward
2b	16.5	MODD	0.64	0-1	100% cobble	no cover	2b	16.5	MODD	0.64	0-1	65% bedrock 25% boulder 5% rubble 5% sand	no cover	rock groyne under water level, windward
3a	240	MODD	0.64	0-1	100% cobble	no cover	3a	240	MODD	1	1-2	50% cobble 50% rubble	no cover	dredged to 1.5m deep, leeward
3b	240	MODD	0.64	0-1	100% cobble	no cover	3b	240	MODD	0.64	1-2	50% cobble 50% rubble	no cover	dredged to 1.5m deep, windward
4a	5.8	COMM	0.64	0-1	100% cobble	no cover	4a	5.8	COMM	1	0-1	50% cobble 50% rubble	no cover	opening left in groyne, leeward
4b	5.8	COMM	0.64	0-1	100% cobble	no cover	4b	5.8	COMM	0.64	0-1	50% cobble 50% rubble	no cover	opening left in groyne, windward
5	444.8	MODI	0.64	0-1	100% cobble	no cover	5	444.8	MODI	1	0-2	50% cobble 50% rubble	no cover	area behind groyne, within dredged area, leeward

Case 24 (cont'd)

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	36.5	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	1	36.5	MODD	1	0-1	30% boulder 10% rubble 5% sand	no cover	added rock platform for dock attachment, leeward
2	3.9	LOSS	1	0-1	30% cobble 65% gravel 5% sand	no cover								rock groyne above water level by 0.32m
3a	22.2	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	3a	22.2	MODD	1	0-1	90% boulder 10% cobble	no cover	rock groyne under water level leeward
3b	22.2	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	3b	22.2	MODD	0.64	0-1	90% boulder 10% cobble	no cover	rock groyne under water level windward
4	205.2	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	4	205.2	MODD	1	0-1	100% sand	no cover	beach, leeward
5a	56.5	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	5a	56.5	MODD	1	1-2	90% clay 10% gravel	no cover	dredged, leeward
5b	56.5	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	5b	56.5	MODD	0.64	1-2	90% clay 10% gravel	no cover	dredged, windward
6a	195.5	MODD	0.64	0-1	30% cobble 65% gravel 5% sand	no cover	6a	195.5	MODD	1	2-3	90% clay 10% gravel	no cover	dredged, leeward

Case 24 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	3.1	LOSS	1	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
2a	16.5	MODD	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
2b	16.5	MODD	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
3a	240	MODD	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
3b	240	MODD	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
4a	5.8	COMM	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
4b	5.5	COMM	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100
5	444.8	MODI	0.64	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2a	16.5	MODD	1	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
2b	16.5	MODD	0.64	100	0	0	0	0	100	0	100	0	0	0	0	0	0	0	100	0	0	100	100
3a	240	MODD	1	0	100	0	0	0	100	0	0	50	50	0	0	0	0	0	100	0	0	100	100
3b	240	MODD	0.64	0	100	0	0	0	100	0	0	50	50	0	0	0	0	0	100	0	0	100	100
4a	5.8	COMM	1	100	0	0	0	0	100	0	0	50	50	0	0	0	0	0	100	0	0	100	100
4b	5.8	COMM	0.64	100	0	0	0	0	100	0	0	50	50	0	0	0	0	0	100	0	0	100	100
5	444.8	MODI	1	40	60	0	0	0	100	0	0	50	50	0	0	0	0	0	100	0	0	100	100

Case 24 (cont'd)

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	36.5	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
2	3.9	LOSS	1	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
3a	22.2	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
3b	22.2	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
4	205.2	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
5a	56.5	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
5b	56.5	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
6a	195.5	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
6b	195.5	MODD	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
7a	4.8	COMM	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
7b	4.8	COMM	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100
8	415.8	MODI	0.64	100	0	0	0	0	100	0	0	30	0	65	5	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	36.5	MODD	1	100	0	0	0	0	100	0	30	0	10	0	50	0	10	0	100	0	0	100	100
3a	22.2	MODD	1	100	0	0	0	0	100	0	90	10	0	0	0	0	0	0	100	0	0	100	100
3b	22.2	MODD	0.64	100	0	0	0	0	100	0	90	10	0	0	0	0	0	0	100	0	0	100	100
4	205.2	MODD	1	100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
5a	56.5	MODD	1	0	100	0	0	0	100	0	0	0	0	10	0	0	90	0	100	0	0	100	100
5b	56.5	MODD	0.64	0	100	0	0	0	100	0	0	0	0	10	0	0	90	0	100	0	0	100	100
6a	195.5	MODD	1	0	0	100	0	0	100	0	0	0	0	10	0	0	90	0	100	0	0	100	100
6b	195.5	MODD	0.64	0	0	100	0	0	100	0	0	0	0	10	0	0	90	0	100	0	0	100	100
7a	4.8	COMM	1	100	0	0	0	0	100	0	5	35	0	55	5	0	0	0	100	0	0	100	100
7b	4.8	COMM	0.64	100	0	0	0	0	100	0	5	35	0	55	5	0	0	0	100	0	0	100	100
8	415.8	MODI	1	40	40	20	0	0	100	0	0	10	0	0	20	0	55	0	100	0	0	100	100

Case 24 (cont'd)
Expected - Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	16.3	37.8	21.5
	Coldwater piscivores	0.17	0	9.7	9.7
	Coolwater non-piscivores	0.17	310.3	431	120.7
	Coolwater piscivores	0.17	39.5	48.9	9.4
	Warmwater non-piscivores	0.17	236.4	350.3	113.9
	Warmwater piscivores	0.17	124.1	261.7	137.6
Spawning	Coldwater non-piscivores	0.17	483.4	368	-115.4
	Coldwater piscivores	0.17	260.3	517.4	257.1
	Coolwater non-piscivores	0.17	309.3	183.8	-125.5
	Coolwater piscivores	0.17	45.4	55.7	10.3
	Warmwater non-piscivores	0.17	247.8	136.2	-111.6
	Warmwater piscivores	0.17	37.6	132.4	94.8
YOY	Coldwater non-piscivores	0.17	132.9	142.1	9.2
	Coldwater piscivores	0.17	0	289	289
	Coolwater non-piscivores	0.17	28.3	95.4	67.1
	Coolwater piscivores	0.17	0	0	0
	Warmwater non-piscivores	0.17	6.4	45.6	39.2
	Warmwater piscivores	0.17	115	147.4	32.4
Weighted Sum					0
Adult		0.33	121.1	189.9	68.8
Spawning		0.33	230.6	232.3	1.7
YOY		0.33	47.1	119.9	72.8
OverAll Sum			132.9	180.7	47.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	3.1	0	0.4	0	-0.4
MODD	51.3	51.3	70.2	89.9	19.7
MODI	444.8	444.8	60.8	88.1	27.3
COMM	11.3	11.6	1.5	2.6	1.1
COMC					
TOTAL			132.9	180.6	47.7

Case 24 (cont'd)

Expected - Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	10.5	34.2	23.7
	Coldwater piscivores	0.17	0	8.8	8.8
	Coolwater non-piscivores	0.17	198.9	389.5	190.6
	Coolwater piscivores	0.17	25.3	44.2	18.9
	Warmwater non-piscivores	0.17	151.6	316.8	165.2
	Warmwater piscivores	0.17	79.6	236.6	157
Spawning	Coldwater non-piscivores	0.17	309.9	335.6	25.7
	Coldwater piscivores	0.17	166.9	467.8	300.9
	Coolwater non-piscivores	0.17	198.3	172.7	-25.6
	Coolwater piscivores	0.17	29.1	50.3	21.2
	Warmwater non-piscivores	0.17	158.9	127	-31.9
	Warmwater piscivores	0.17	24.1	119.8	95.7
YOY	Coldwater non-piscivores	0.17	85.2	128.4	43.2
	Coldwater piscivores	0.17	0	260.1	260.1
	Coolwater non-piscivores	0.17	18.2	86.3	68.1
	Coolwater piscivores	0.17	0	0	0
	Warmwater non-piscivores	0.17	4.1	41.3	37.2
	Warmwater piscivores	0.17	73.7	133.2	59.5
Weighted Sum					0
Adult		0.33	77.7	171.7	94
Spawning		0.33	147.9	212.2	64.3
YOY		0.33	30.2	108.2	78
Over All Sum			85.2	164	78.8

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	3.1	0	0.4	0	-0.4
MODD	328.3	420.7	44.9	73.8	28.9
MODI	284.7	444.8	38.9	88.1	49.2
COMM	7.2	9.5	1	2.1	1.1
COMC	-	-	-	-	-
TOTAL			85.2	164	78.8

Case 24 (cont'd)
Actual - Not Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	75.7	41.1	-34.6
	Coldwater piscivores	0.17	26.5	11.3	-15.2
	Coolwater non-piscivores	0.17	965.3	351.5	-613.8
	Coolwater piscivores	0.17	104.1	109.4	5.3
	Warmwater non-piscivores	0.17	686.8	236.7	-450.1
	Warmwater piscivores	0.17	547.1	244.6	-302.5
Spawning	Coldwater non-piscivores	0.17	1024	334	-690
	Coldwater piscivores	0.17	916.5	194.8	-721.7
	Coolwater non-piscivores	0.17	957.8	247.3	-710.5
	Coolwater piscivores	0.17	86.2	89.1	2.9
	Warmwater non-piscivores	0.17	938.5	278.8	-659.7
	Warmwater piscivores	0.17	215.3	66.3	-149
YOY	Coldwater non-piscivores	0.17	377.9	211.7	-166.2
	Coldwater piscivores	0.17	766.3	314.7	-451.6
	Coolwater non-piscivores	0.17	572.5	320	-252.5
	Coolwater piscivores	0.17	28.3	56.4	28.1
	Warmwater non-piscivores	0.17	152.5	96.1	-56.4
	Warmwater piscivores	0.17	182.4	155.9	-26.5
Weighted Sum					0
Adult		0.33	400.9	165.8	-235.1
Spawning		0.33	689.7	201.7	-488
YOY		0.33	346.6	192.5	-154.1
Over All Sum			479.1	186.7	-292.4

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	3.9	0	1.5	0	-1.5
MODD	790.1	790.1	310.4	138.9	-171.5
MODI	415.8	353.4	163.4	44.4	-119
COMM	9.6	9.6	3.8	3.4	-0.4
COMC	-	-	-	-	-
TOTAL			479.1	186.7	-292.4

Case 24 (cont'd)
Actual - Applying Indirect Effect

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	48.5	38.8	-9.7
	Coldwater piscivores	0.17	17	11	-6
	Coolwater non-piscivores	0.17	618.9	341.3	-277.6
	Coolwater piscivores	0.17	66.7	101.4	34.7
	Warmwater non-piscivores	0.17	440.3	229.9	-210.4
	Warmwater piscivores	0.17	350.8	237.6	-113.2
Spawning	Coldwater non-piscivores	0.17	656.5	320.4	-336.1
	Coldwater piscivores	0.17	587.6	185.4	-402.2
	Coolwater non-piscivores	0.17	614.1	243.8	-370.3
	Coolwater piscivores	0.17	55.3	87.4	32.1
	Warmwater non-piscivores	0.17	601.7	274	-327.7
	Warmwater piscivores	0.17	138.1	63.9	-74.2
YOY	Coldwater non-piscivores	0.17	242.3	205.8	-36.5
	Coldwater piscivores	0.17	491.3	305.9	-185.4
	Coolwater non-piscivores	0.17	367	314.5	-52.5
	Coolwater piscivores	0.17	18.1	55.1	37
	Warmwater non-piscivores	0.17	97.8	94.5	-3.3
	Warmwater piscivores	0.17	116.9	149.5	32.6
Weighted Sum					0
Adult		0.33	257	160	-97
Spawning		0.33	442.2	195.8	-246.4
YOY		0.33	222.2	187.6	-34.6
Over All Sum			307.2	181.1	-126.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	3.9	0	1.5	0	-1.5
MODD	505.7	691.4	198.7	134	-64.7
MODI	266.1	353.4	104.6	44.4	-60.2
COMM	6.1	7.9	2.4	2.8	0.4
COMC	-	-	-	-	-
TOTAL			307.2	181.2	-126

Case 25. Modification of Existing Groyne, Georgian Bay, Collingwood

Receive Date: 2000/03/01
Project Location: Georgian Bay, Lake Huron, Burlington Distict

Project Activity
Proposal: Installation of concrete blocks to widen existing groyne, removal of end portion of groyne, dredging of boat access and construction of beach area.
Size of Work Area: 825.8m^2.
Description of Work: Thirty four concrete blocks resulting in infilling of 22.7m^2 of habitat. 587m^2 of lakebed in dredged area stabilized using peagravel, 0.1m in depth.
Material Used: Concrete blocks 1.8m x 0.9m, peagravel.

Pre Condition
Substrate composed primarily of gravel and cobble. Area provides rearing habitat for YOY of cool and warm water fish species.

Compensation
Proposal: Construct opening in existing groyne to facilitate water circulation in the area.
Size of Compensation Area: 15m^2.
Description of Work: Removal of portion of rock groyne to create 15m^2 opening to be restored and stabilized.
Material Used: Rock removed and stabilizing measures not specified.

HAAT Analysis
Assumptions: Authorization does not state area of infill so calculated based upon number of blocks proposed. Depth of dredging not specified so estimated based upon design drawings and assumed within 1-2m depth zone. Addition of sand not in Authorization but included in site plan and file notes so included as MODD (199.6m^2) calculated from site plan.
Results:

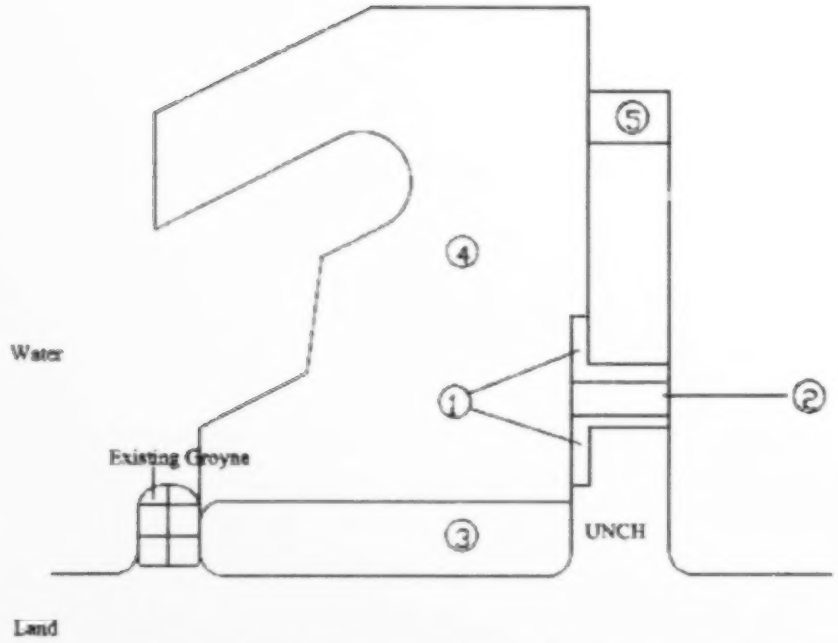
- Overall project resulted in net gain of fish habitat
- Largest gain in fish habitat for YOY's, with highest gain for YOY cold water piscivores.
- Negative net loss predicted for all spawning non-piscivores (cold, cool, and warm water species).

Case 25. Modification of Existing Groyne, Collingwood, Georgian Bay

Expected Scenario

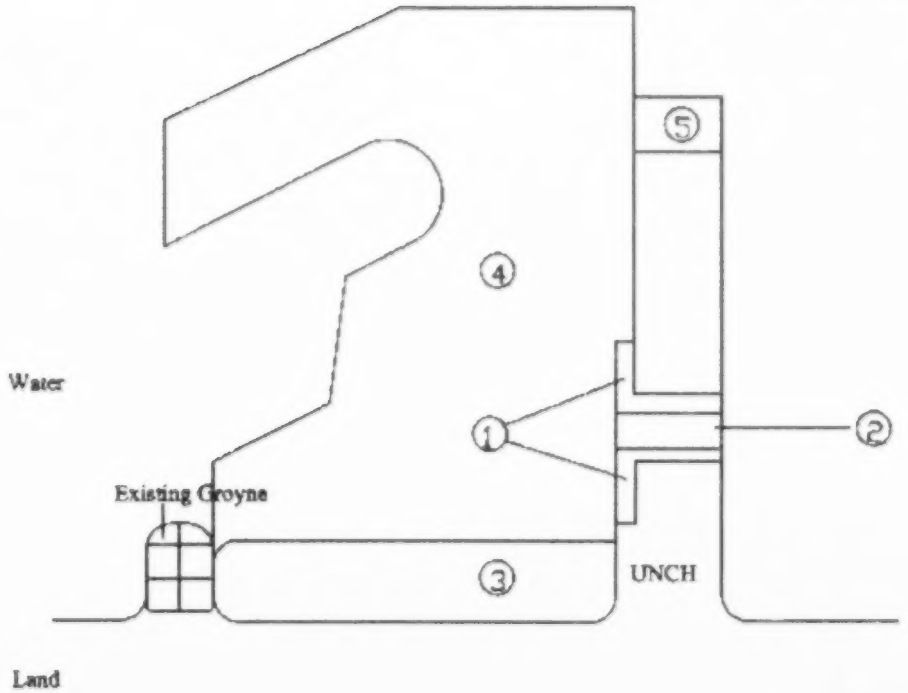
Pre-Construction phase photograph not available

Post-Construction Phase



Case 25. Modification of Existing Groyne, Collingwood, Georgian Bay (Actual Scenario)

Post-Construction Phase (Pre-Construction phase photo not available)



Case 25 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	22.7	LOSS		0-1	50% gravel 50% cobble	no cover								addition of blocks - infil, 14block base
							2	15	COMC		0-1	100% gravel	no cover	creation of opening for comp.
3	199.6	MODD		0-1	15% sand 40% gravel 40% cobble 5% silt	no cover	3	199.6	MODD		0-1	100% sand	no cover	area of beach below water line
4	587	MODD		was 0-1	15% sand 40% gravel 40% cobble 5% silt	no cover	4	587	MODD		now 1-2	100% gravel	no cover	dredged area with pea gravel
5	16.5	MODD		0-1	50% gravel 50% cobble	no cover	5	16.5	MODD		0-1	100% gravel	no cover	dredged at tip groyne

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	24.3	LOSS		0-1	15% sand 40% gravel 40% cobble 5% silt	no cover								addition of blocks - infil 15block base
							2	20	COMC		0-1	95% sand 5% gravel	no cover	creation of opening for comp.
3	199.6	MODD		0-1	15% sand 40% gravel 40% cobble 5% silt	no cover	3	199.6	MODD		0-1	95% sand 5% gravel	no cover	beach below water line
4	587	MODD		was 0-1	15% sand 40% gravel 40% cobble 5% silt	no cover	4	587	MODD		now 1-2	30% clay 35% sand 25% gravel 10% cobble	no cover	dredged area
5	16.5	MODD		0-1	15% sand 40% gravel 40% cobble 5% silt	no cover	5	16.5	MODD		0-1	95% sand 5% gravel	no cover	dredged at tip groyne

Case 25 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	22.7	LOSS		100	0	0	0	0	100	0	0	50	0	50	0	0	0	0	100	0	0	100	100
3	199.6	MODD		100	0	0	0	0	100	0	0	40	0	40	15	5	0	0	100	0	0	100	100
4	587	MODD		100	0	0	0	0	100	0	0	40	0	40	15	5	0	0	100	0	0	100	100
5	16.5	MODD		100	0	0	0	0	100	0	0	50	0	50	0	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	15	COMC		100	0	0	0	0	100	0	0	0	0	100	0	0	0	0	100	0	0	100	100
3	199.6	MODD		100	0	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0	100	100
4	587	MODD		0	100	0	0	0	100	0	0	0	0	100	0	0	0	0	100	0	0	100	100
5	16.5	MODD		100	0	0	0	0	100	0	0	0	0	100	0	0	0	0	100	0	0	100	100

Case 25 (cont'd)

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	24.3	LOSS		100	0	0	0	0	100	0	0	40	0	40	15	5	0	0	100	0	0	100	100
3	199.6	MODD		100	0	0	0	0	100	0	0	40	0	40	15	5	0	0	100	0	0	100	100
4	587	MODD		100	0	0	0	0	100	0	0	40	0	40	15	5	0	0	100	0	0	100	100
5	16.5	MODD		100	0	0	0	0	100	0	0	40	0	40	15	5	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	20	COMC		100	0	0	0	0	100	0	0	0	0	5	95	0	0	0	100	0	0	100	100
3	199.6	MODD		100	0	0	0	0	100	0	0	0	0	5	95	0	0	0	100	0	0	100	100
4	587	MODD		100	100				100	0	0	10	0	25	35	0	30	0	100	0	0	100	100
5	16.5	MODD		100					100	0	0	0	0	5	95	0	0	0	100	0	0	100	100

Case 25 (cont'd)
Expected

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	45	66.7	21.7
	Coldwater piscivores	0.17	15.2	25.4	10.2
	Coolwater non-piscivores	0.17	560.2	801.6	241.4
	Coolwater piscivores	0.17	70.7	91.2	20.5
	Warmwater non-piscivores	0.17	397.8	556.1	158.3
	Warmwater piscivores	0.17	336.8	488.4	151.6
Spawning	Coldwater non-piscivores	0.17	598.6	522.3	-76.3
	Coldwater piscivores	0.17	483.6	703.3	219.7
	Coolwater non-piscivores	0.17	541	325.9	-215.1
	Coolwater piscivores	0.17	73.7	88.5	14.8
	Warmwater non-piscivores	0.17	529	311.2	-217.8
	Warmwater piscivores	0.17	113.1	181.5	68.4
YOY	Coldwater non-piscivores	0.17	241.7	433.7	192
	Coldwater piscivores	0.17	410.8	784	373.2
	Coolwater non-piscivores	0.17	371.4	613.9	242.5
	Coolwater piscivores	0.17	35.1	113.5	78.4
	Warmwater non-piscivores	0.17	100.3	158	57.7
	Warmwater piscivores	0.17	141.3	161.2	19.9
Weighted Sum					0
Adult		0.33	237.6	338.2	100.6
Spawning		0.33	389.8	355.5	-34.3
YOY		0.33	216.7	377.4	160.7
Over All Sum			281.4	357	75.6

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	22.7	0	7.3	0	-7.3
MODD	803.1	803.1	274.1	349.5	75.4
MODI	-	-	-	-	-
COMM	-	-	-	-	-
COMC	0	15	0	7.6	7.6
TOTAL			281.4	357.1	75.7

Case 25 (cont'd)

Actual

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	45.3	78.6	33.3
	Coldwater piscivores	0.17	15.4	29.1	13.7
	Coolwater non-piscivores	0.17	562.1	935.3	373.2
	Coolwater piscivores	0.17	71.5	154.8	83.3
	Warmwater non-piscivores	0.17	398.8	640.6	241.8
	Warmwater piscivores	0.17	339.6	601.7	262.1
Spawning	Coldwater non-piscivores	0.17	598.7	724.2	125.5
	Coldwater piscivores	0.17	482.5	606.5	124
	Coolwater non-piscivores	0.17	541.9	609.3	67.4
	Coolwater piscivores	0.17	75.2	171.5	96.3
	Warmwater non-piscivores	0.17	530.6	640.1	109.5
	Warmwater piscivores	0.17	113.2	185.1	71.9
YOY	Coldwater non-piscivores	0.17	243.7	532.6	288.9
	Coldwater piscivores	0.17	413.5	845.4	431.9
	Coolwater non-piscivores	0.17	376.9	829.4	452.5
	Coolwater piscivores	0.17	36.4	142.6	106.2
	Warmwater non-piscivores	0.17	101.9	238.4	136.5
	Warmwater piscivores	0.17	143.1	295.6	152.5
Weighted Sum					0
Adult		0.33	238.8	406.7	167.9
Spawning		0.33	390.4	489.4	99
YOY		0.33	219.3	480.7	261.4
Over All Sum			282.8	458.9	176.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	24.3	0	8.3	0	-8.3
MODD	803.1	1390.1	274.5	449.1	174.6
MODI	-	-	-	-	-
COMM	-	-	-	-	-
COMC	0	20	0	9.8	9.8
TOTAL			282.8	458.9	176.1

Case 26. Shoreline Protection, Sturgeon Bay, Georgian Bay, Waubaushene

Receive Date: 1998/11/01
Project Location: Sturgeon Bay, Georgian Bay, Burlington District

Project Activity
Proposal: Replacement of decrepit railway tie retaining wall with armourstone revetment.
Size of Work Area: $4m^2$.
Description of Work: Removal of railway ties extending 9.8m and gabion baskets extending 7.3m. Structure entirely within 0-1 depth zone, resulting in the loss of $4m^2$ of fish habitat.
Material Used: Armour stones 0.8m wide and 1.2m long.

Pre Condition
Substrate comprised of cobble sandy substrate within 0-1 depth zone.

Compensation
Proposal: Use of armourstone wall as construction material considered sufficient compensation by providing interstitial spaces and bank protection.
Size of Compensation Area: $3m^2$.
Description of Work: Installation of armourstone revetment.
Material Used: 0.8m wide and 1.2m long armourstone blocks.

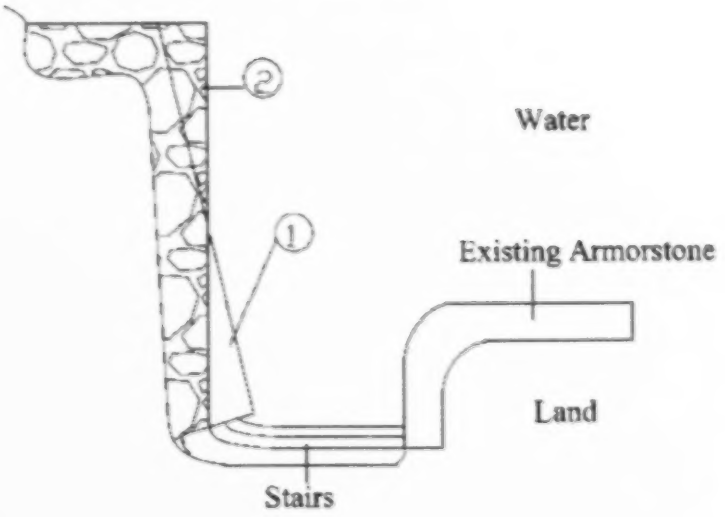
HAAT Analysis
Assumptions: Replacement of gabion baskets with rock revetment considered equal composition and therefore considered habitat unchanged and not included in calculations. Considered armourstone wall as substrate comprised of boulder and bedrock due to habitat availability in interstitial spaces. Determined pre-development substrate composition based upon limited description in project file notes. Area of compensation calculated based on description of work (area not specified in Authorization).
Results:

- Overall project resulted in minor loss of fish habitat.
- Habitat for spawners affected slightly more than adults or YOY.
- Cool water non-piscivorous adults most affected.

Case 26. Shoreline Protection, Sturgeon Bay, Waubaushene, Georgian Bay

Expected Scenario

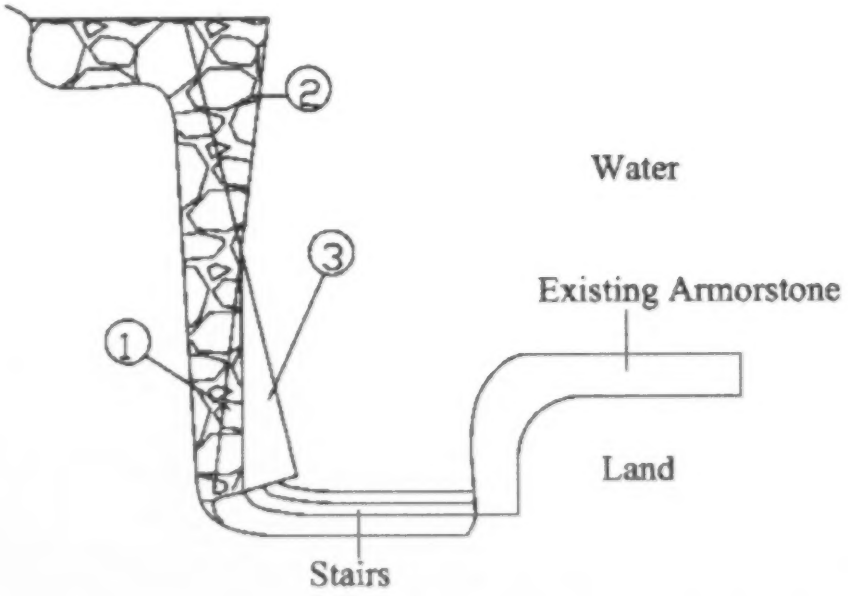
Pre-Construction Phase



Case 26. Shoreline Protection, Sturgeon Bay, Waubaushene, Georgian Bay (Actual Scenario)

Pre-Construction Phase

Post-Construction Phase



Case 26 (cont'd)

Expected

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	3.75	LOSS		0-1	50% cobble 50% sand	no cover								infill as per Auth.
							2	3	COMC		0-1	tiered armourstone wall =50% bedrock 50% boulder	no cover	replacement of vertical ties with tiered armourstone

Actual

PRE-Development Scenario							POST-Development Scenario							
ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	ID #	Area (m²)	Habitat Type	Condition Index	Depth Zone (m)	Substrate	Cover	What Changed?
1	1.2	LOSS		0-1	90% sand 10% gravel	no cover								armourstone rock revetment
							2	6.4	COMC		0-1	tiered armour stone and area adj. to wall= 40% bedrock 40% boulder 20% sand	no cover	replacement of vertical ties with tiered armourstone
3	1.2	MODD		0-1	90% sand 10% gravel	no cover	3	1.2	MODD		0-1	50% bedrock 50% boulder	no cover	lower level tiered wall

Case 26 (cont'd)

Expected PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	3.75	LOSS		100	0	0	0	0	100	0	0	50	0	10	50	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	3	COMC		100	0	0	0	0	100	50	50	50	0	0	0	0	0	0	100	0	0	100	100

Actual PRE Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
1	1.2	LOSS		100	0	0	0	0	100	0	0	0	0	10	90	0	0	0	100	0	0	100	100
3	1.2	MODD		100	0	0	0	0	100	0	0	0	0	10	90	0	0	0	100	0	0	100	100

POST Condition

ID	Area	AreaType	CI	Depth					*	Substrate									*	Cover			*
*				0-1	1-2	2-5	5-10	10+	SUM	bedrock	boulder	cobble	rubble	gravel	sand	silt	clay	hardpan	SUM	submerg	emerg	no cover	SUM
2	6.4	COMC		100	0	0	0	0	100	40	40	0	0	0	20	0	0	0	100	0	0	100	100
3	1.2	MODD		100	0	0	0	0	100	50	50	0	0	0	0	0	0	0	100	0	0	100	100

Case 26 (cont'd)
Expected

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	0.2	0.1	-0.1
	Coldwater piscivores	0.17	0.1	0	-0.1
	Coolwater non-piscivores	0.17	2.3	0.4	-1.9
	Coolwater piscivores	0.17	0.3	0.1	-0.2
	Warmwater non-piscivores	0.17	1.6	0.2	-1.4
	Warmwater piscivores	0.17	1.4	0.2	-1.2
Spawning	Coldwater non-piscivores	0.17	2.5	0.8	-1.7
	Coldwater piscivores	0.17	1.3	0.6	-0.7
	Coolwater non-piscivores	0.17	2.1	0.3	-1.8
	Coolwater piscivores	0.17	0.5	0.1	-0.4
	Warmwater non-piscivores	0.17	2.1	0.1	-2
	Warmwater piscivores	0.17	0.4	0.3	-0.1
YOY	Coldwater non-piscivores	0.17	1.3	0.2	-1.1
	Coldwater piscivores	0.17	1.6	0	-1.6
	Coolwater non-piscivores	0.17	1.8	0.1	-1.7
	Coolwater piscivores	0.17	0.3	0	-0.3
	Warmwater non-piscivores	0.17	0.5	0	-0.5
	Warmwater piscivores	0.17	0.9	0.3	-0.6
Weighted Sum					0
Adult		0.33	1	0.2	-0.8
Spawning		0.33	1.5	0.4	-1.1
YOY		0.33	1.1	0.1	-1
OverAll Sum			1.2	0.2	-1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	3.8	0	1.2	-	-1.2
MODD	-	-	-	-	-
MODI	-	-	-	-	-
COMM	-	-	-	-	-
COMC	0	3	0	0.2	0.2
TOTAL			1.2	0.2	-1.0

Case 26 (cont'd)
Actual

Lake: Weighted Useable Areas m^2

Type	Group ID	Weight	PRE	POST	Net Change
Adult	Coldwater non-piscivores	0.17	0.2	0.2	0
	Coldwater piscivores	0.17	0.1	0	-0.1
	Coolwater non-piscivores	0.17	2.2	2.1	-0.1
	Coolwater piscivores	0.17	0.3	0.3	0
	Warmwater non-piscivores	0.17	1.4	1.1	-0.3
	Warmwater piscivores	0.17	1.5	1.2	-0.3
Spawning	Coldwater non-piscivores	0.17	2	2.7	0.7
	Coldwater piscivores	0.17	1.2	1.7	0.5
	Coolwater non-piscivores	0.17	2	1.6	-0.4
	Coolwater piscivores	0.17	0.5	0.4	-0.1
	Warmwater non-piscivores	0.17	2.1	1.3	-0.8
	Warmwater piscivores	0.17	0.4	0.9	0.5
YOY	Coldwater non-piscivores	0.17	1.3	1.1	-0.2
	Coldwater piscivores	0.17	2	1.1	-0.9
	Coolwater non-piscivores	0.17	2.2	1.5	-0.7
	Coolwater piscivores	0.17	0.3	0.2	-0.1
	Warmwater non-piscivores	0.17	0.6	0.3	-0.3
	Warmwater piscivores	0.17	0.8	1.1	0.3
Weighted Sum					0
Adult		0.33	1	0.8	-0.2
Spawning		0.33	1.4	1.5	0.1
YOY		0.33	1.2	0.9	-0.3
OverAll Sum			1.2	1.1	-0.1

Lake: Areas and WSA's by Area Type and Scenario m^2

Habitat Type	Areas		WSAs		Net Change
	PRE	POST	PRE	POST	
LOSS	1.2	0	0.6	0	-0.6
MODD	1.2	1.2	0.6	0.1	-0.5
MODI	-	-	-	-	
COMM	-	-			
COMC	0	0.4	0	1	1
TOTAL			1.2	1.1	-0.1